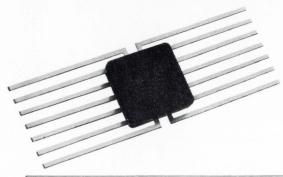
EGGPONG DESIGN 12 THE MAGAZINE OF ESSENTIAL NEWS, PRODUCTS AND TECHNOLOGY VOL. 14, NO. 12 MAY 17, 1966

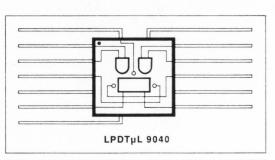


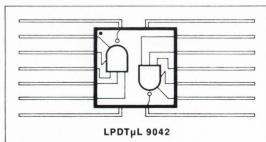
When the chips are down, an applications-oriented semiconductor directory is your best bet for optimum device selection. Bipolars, FETs, UJTs and

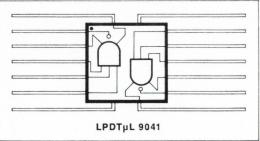
integrated circuits are listed by key parameters. You also learn who-makes-what in diodes, SCRs and rectifiers. Articles show design basics, trade-offs.

FAIRCHILD LOW POWER LOGIC









FEATURES:

Low Power drainless than 1mW/gate (typ.) @ 50% duty cycle less than 4mW/clocked flip-flop

Single power supply requirement 5V optimum, 4.5V to 5.5V range Guaranteed noise immunity 450mV min. at temperature extremes

Logic propagation delays 60nsec. typical

LPDTµL LOW POWER DIODE-TRANSISTOR MICROLOGIC™ CIRCUITS

Fairchild LPDT_µL integrated circuits offer high performance in the low milliwatt range. High resistance values and small chip geometry hold down power consumption. The flip-flop element operates either in the R-S or J-K mode, with maximum dissipation of 6mW at a 2Mc toggle rate. Gates provide fan-out capability of 10 LPDT_uL low power logic unit loads. or one standard Fairchild DT μ L diode-transistor logic unit load. (Standard Fairchild DT μ L logic circuits can be used to extend the fan-out capability still further). The circuits come in Fairchild's Cerpak flat package, and can be used in satellites, battery-operated field equip-

ment, or other instruments where reliability and high performance must be achieved with limited power. Fairchild LPDT_µL low power integrated circuits are available in **FAIRCH** evaluation quantities from distributors. For complete information write to:



ELECTRONIC DESIGN'S SEMICONDUCTOR DIRECTORY 1966

Mark B. Leeds, Rene Colen Technical Editors

Here is the industry's only complete applications-oriented semiconductor directory. Combining Electronic Design's fourteenth annual transistor data chart and third annual microelectronics data chart with a who-makes-what diode guide, the directory gives you in one package:

- All the device information you need to pinpoint solid-state design needs—listed according to major design parameters.
- Technical articles explaining how to use the specifications, major application areas and the governing design parameters.
- Convenient Reader-Service Card (good for a full year) to order detailed device specifications direct from the manufacturer.

Transistors are classified according to seven application categories: Audio and General-Purpose, High-Frequency, Power, Low-Level Switching, High-Level Switching, Unijunction and Field-Effect. Within each category, types are arranged in order of improving values of a key design parameter. This listing method permits rapid identification of close substitutes, because device specifications can be compared at a glance. The manufacturer listed in the "Mfr." column is the original registrant of the type for which data are supplied. Alternate suppliers are listed in the "Remarks" column.

The diode chart provides a fast guide to the manufacturers who make the specific type of diode you need.

Microelectronic devices are divided into two major categories: Digital and Linear. Within these categories the devices are listed by logic type, in the case of digital circuits, and by application, in the case of linear circuits.

Cross-indexes for both transistors and microcircuits simplify the job of finding the specific device when the type number is known.

Keep your semiconductor data up-to-date by doing the following:

Step 1: Obtain specification sheets and other data, by finding the appropriate numbers on the manufacturers' literature list (pp. 4-9) and circling them on the Reader-Service Card.

Step 2: Get your own copy of the 1966 Semiconductor Directory by circling Reader-Service No. 500.

May 17, 1966

Looks are deceiving...

CDE's new XTX capacitor packs T3 capacitance in a T2 case!

Meet the XTX...a totally new tantalum capacitor with unmatched volumetric efficiency. A capacitor which offers twice the capacitance value of the CL65-yet retains CL65 case sizes! Voltage range is widest, too: from 6 all the way to 100.

The inside story? Dependability. CDE's exclusive seal construction virtually eliminates the possibility of electrolytic leakage. Rugged internal construction makes the XTX incredibly shock and vibration-resistant. It is, in fact, an advanced product...one just right for computer circuitry, copy machines and many other applications.

CDE's new XTX capacitor: just another example of doing the

job just a little better.

CALL YOUR CDE AUTHORIZED INDUSTRIAL DISTRIBUTOR.



Table of Contents

- 4 List of manufacturers and their literature offerings.
- 208 Technical article reprints and reader service card.

TRANSISTORS

- 10 Parameters key applications, govern transistor selection.
- 18 How to use the charts and key to transistor types.
- 21 Transistor who-makes-what chart.
- 22 Bipolar transistor data charts:
- Audio and general purpose.
 High-frequency.
 High-level switching.
- 56 Power.
- 94 For the how, why and where of FET usage, consult parameters.
- 104 Field-effect transistor data charts:
- 104 Analog switching.
 106 Digital switching.
 107 Low-drift single-ended dc amplifier.
 108 General-purpose ac amplifier.
 111 Low-noise ac amplifier.
 112 High-frequency ac amplifier.
- 114 Use the UJT that does the job best.
- 118 Unijunction transistor data charts:
- 118 Pulse generating and 118 High-frequency control. SCR triggering. 118 Low-frequency control.
- 122 Transistor cross-index (bipolars, FETs and UJTs).

DIODES/RECTIFIERS

- 144 Selecting thyristors to fill a control need?
- 156 In choosing diodes, don't settle for second-best!
- 164 Diode data chart (who-makes-what).

MICROELECTRONICS

- 170 Choosing ICs needn't be a chore.
- 174 Microelectronics data charts:
- 174 Diode-transistor logic. 192
- 180 Direct-coupled transistor logic and resistor-transistor logic
- 184 Transistor-transistor logic
- 190 Emitter-coupled logic
- 200 Microelectronics cross-index.
- 192 Resistor-capacitor logic.
- 194 Complementary-transistor logic.
- 195 Digital circuits (miscellaneous types).
- 196 Linear circuits.



The cover photo, courtesy of Fairchild Semiconductor, Mountain View, Calif., shows a number of popular solid-state devices. At the upper right is part of an SCR (2N4319 type); resting on the left portion of the SCR structure is a FET (F1100 type); in the center foreground is a 2N1724 power transistor with an isolated collector; to its left, a hybrid flip-flop (SH2300 type); slightly above and to the right of the flip-flop is a μ A709 monolithic operational amplifier; at the extreme upper left is part of a dual-bipolar unit (2N2060 type).

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List of Manufacturers and their literature offerings

Bring your semiconductor data file up to date. Use the Reader-Service card to obtain data sheets, catalogs, application notes and other useful information. Consult dot charts (Transistors: p. 21, Diodes/Rectifiers: p. 164, and Microelectronics: p. 179, 182, 188) to learn who makes what in each device category. Starred (*) listings mean requests for literature and data sheets must go directly to the manufacturers.

Code	Company	Type of Information Offered	Transistor	Diode	Micro- electronics
	Airtron Div., Litton Industries 200 E. Hanover Ave. Morris Plains, N.J. 07950 (201) 539-5500	Data sheets. Article reprints.		201	
	Alpha Industries 381 Elliot St. Newton Upper Falls, Mass. 02164 (617) 969-5310	Data sheets. Catalogs. Customer applications service.		202	
AL	Amelco Semiconductor 1300 Terra Bella Ave. Mountain View, Calif. 94042 (415) 968-9241	Short form catalog.	203		204
	American Electronic Laboratories Inc. P.O. Box 552 Lansdale, Pa. 19446 (215) 822-2929	Data sheets. Catalogs. Article reprints. Customer applications service.		205	
	American Semiconductor Corp. 4 N. Hickory Ave. Arlington Heights, III. 60004 (312) 392-8830	Data sheets. Catalogs.		206	
AMP	American Semiconductor Corp. 4 N. Hickory Ave. Arlington Heights, III. 60004 (312) 392-8830	Data sheets. Catalogs. Application notes. Customer applications service. Design aids.	207	208	209
	Atlantic Semiconductor Inc. 905 Mattison Ave. Asbury Park, N.J. 07712 (201) 775-1827	Data sheets. Catalogs. Data manuals.		210	
	Bell, F. W., Inc. 1356 Norton Ave. Columbus, Ohio 43212 (614) 294-4906	Data sheets.		211	

Code	Company	Type of Information Offered	Transistor	, Diode	Micro- electronics
BE	Bendix Semiconductor Div. South St. Holmdel, N.J. 07733 (201) 747-5400	Catalogs. Design aids.	212	213	
	Bradley Semiconductor Corp. 275 Welton St. New Haven, Conn. 06506 (203) 787-7181	Data sheets.		214	
BU	Burroughs Corp. Electronic Components Div. P.O. Box 1226 Plainfield, N.J. 07061 (201) 757-5000	Data sheets. Facilities brochure.	215	216	
CBS	CBS Laboratories High Ridge Road Stamford, Conn. (203) 325-4321			*	*
	Chatham Electronics Div. Tung-Sol Electric Inc. 630 W. Mt. Pleasant Ave. Livingston, N.J. 07039 (201) 992-1100	Data sheets. Catalogs.		217	
	Computer Diode Corp. Pollitt Drive Fair Lawn, N.J. 07410 (201) 797-3900	Data sheets.		218	
	Conant Laboratories 6500 O St. Lincoln, Neb. 68501 (402) 488-0432	Catalogs.		219	
CDC	Continental Device Corp. 12515 Chadron St. Hawthorne, Calif. 90250 (213) 772-4551	Data sheets. Catalogs. Article reprints.	220	221	

Code	Company	Type of Information Offered	Transistor	Diode	Micro-
СТ	Crystalonics Inc. 147 Sherman St. Cambridge, Mass. 02140 (617) 491-1670	Short form catalog.	222	223	
DE	Delco Radio Div., General Motors Corp. 700 E. Firmin St. Kokomo, Ind. 46901 (317) 457-8461	Short form catalog.	224	225	
	Delta Semiconductors Inc. 879 W. 16th St. Newport Beach, Calif. 92660 (714) 646-3286	Data sheets, Catalogs.		226	
DIC	Dickson Electronics Corp. P.O. Box 1387 Scottsdale, Ariz. 85252 (602) 947-5751	Data sheets. Catalogs. Application notes. Article reprints. Customer applications service.	227	228	
	Diodes Incorporated 20235 Nordhoff Chatsworth, Calif. 91311 (213) 341-4850	Data sheets. Catalogs.		229	
	Eastern Delta Corp. 29-09 Broadway Fairlawn, N.J. 07411 (201) 797-4200	Data sheets.		230	
	Eastron Corp. 25 Locust St. Haverhill, Mass. 01830 (617) 373-3824	Data sheets. Catalogs. Application notes.		231	
	Edal Industries 4 Short Beach Road East Haven, Conn. 06512 (203) 467-2591	Data sheets. Catalogs. Article reprints. Customer applications service. Design aids.		232	
	Edgerton, Germeshausen & Grier, Inc. 160 Brookline Ave. Boston, Mass. 02215 (617) 267-9700	Data sheets. Application notes.		233	
	Electro-Optical Systems Inc. 255 N. Halstead Pasadena, Calif. 91107 (213) 449-1230			*	
	Electronic Devices Inc. 21 Gray Oaks Ave. Yonkers, N.Y. 10710 (914) 965-4400	Data sheets.		235	
ETC	Electronic Transistors Corp. 153-13 Northern Blvd. Flushing, N.Y. 11354 (212) 539-6700	Data sheets. Catalogs.	236		
	Erie Technological Products Inc. 644 W. 12th St. Erie, Pa. 16512 (814) 456-8592	Catalogs. Application notes.		237	
FA	Fairchild Semiconductor 313 Fairchild Drive Mountain View, Calif. 94040 (415) 962-5011	Data sheets. Catalogs. Application notes. Article reprints. Customer applications service.	238	239	240
	Fansteel Metallurgical Corp. Number One Tantalum Place North Chicago, III. 60064 (312) 336-4900			*	

Code	Company	Type of Information Offered	Transistor	Diode	Micro-
GE	General Electric Co. Semiconductor Products Dept. Bldg. 7, Electronics Park Syracuse, N.Y. (315) 456-2798	Data sheets. Catalogs. Application notes. Article reprints.	242	243	244
GI	General Instrument Corp. Technical Service Center 600 W. John St. Hicksville, N.Y. 11802 (516) 681-8000	Data sheets. Catalogs.	245	246	247
GME	General Micro-electronics Inc. 2920 San Ysidro Way Santa Clara, Calif. 95051 (408) 245-2966	Catalogs.	248	7	249
	General Semiconductors, Inc. 230 W. 5th St. Tempe, Ariz. 85281 (682) 966-7263	Data sheets. Catalogs. Data manuals. Customer applications service.		250	
	Green Rectifier Corp. 1-10 30 St. Fairlawn, N.J. 07411 (201) 797-8100			*	
	HP Associates 620 Page Mill Road Palo Alto, Calif. 94304 (415) 321-8510	Data sheets. Application notes.		252	
	Heliotek Div., Textron Electronics Inc. 12500 Gladstone Ave. Sylmar, Calif. 91342 (213) 365-6301			*	
HOF	Hoffman Electronics Corp. Semiconductor Div. Hoffman Electronic Park El Monte, Calif. 91734 (213) 686-0123	Data sheets. Catalogs. Application notes. Article reprints.	254	255	256
HU	Hughes Aircraft Co. Microelectronics Div. 500 Superior Ave. Newport Beach, Calif. 92663 (714) 548-0671	Data sheets. Application notes.	257	258	259
	Hunt Electronics Co. 2617 Andjon Dallas, Tex. 75220 (214) 352-8421			*	
ITT	ITT Semiconductors 3301 Electronics Way West Palm Beach, Fla. 33402 (305) 842-2411	Catalogs.	260	261	262
IND	Industro Transistor Corp. 35-10 36th Ave. Long Island City, N.Y. (212) 392-8000		*		
	Instrument Systems Corp. 770 Park Ave. Huntington, N.Y. (516) 423-6200	Data sheets.		264	
IN	Intellux, Inc. 26 Coromar Dr. Goleta, Calif. 93017 (805) 968-3541	Data sheets. Catalogs. Application notes. Article reprints. Data manuals. Customer applications service. Design aids.			265
	International Diode Corp. 90 Forrest St. Jersey City, N.J. 07304 (201) 432-7151			*	

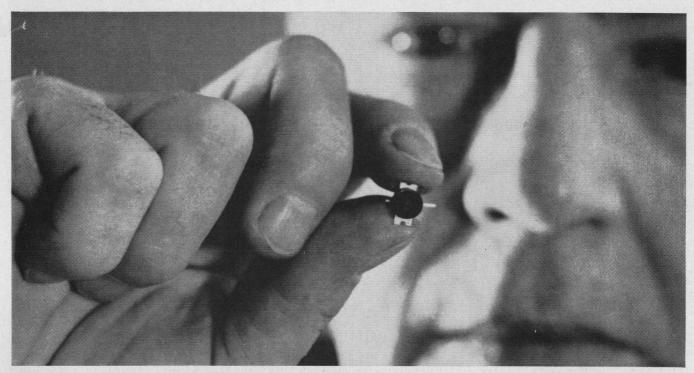
May 17, 1966 5

Code	Company	Type of Information Offered	Transistor	Diode	Micro-
IEC	International Electronics Corp. 316 South Service Road Melville, L.I., N.Y. 11749 (516) 694-7700	Data sheets. Catalogs. Customer applications service.	267	268	
	International Rectifier Corp. 233 Kansas St. El Segundo, Calif. 90245 (213) 678-6281	Data sheets. Catalogs. Application notes. Article reprints. Customer applications service. Design aids.		269	
	IRC Inc., Semiconductor Div. 71 Linden St. W. Lynn, Mass. 01905 (617) 598-4800	Data sheets. Catalogs. Customer applications service. Data sheets. Catalogs. Application notes. Article reprints. Customer applications service.		270	
KMC	KMC Semiconductor Corp. Parker Road Long Valley, N.J. 07853 (201) 876-3811	Application notes. Article reprints. Customer applications	271	272	
KSC	KSC Semiconductor Corp. 437 Cherry St. West Newton, Mass. (617) 969-8451		*		
	Korad Corp. 2520 Colorado Ave. Santa Monica, Calif. 90404 (213) 393-6737			*	
LAN	Lansdale Transistor & Electronics Inc. 1111 N. Broad St. Lansdale, Pa. 19446 (215) 855-9004		*		
	Ledex, Inc. 123 Webster St. Dayton, Ohio 45402 (513) 224-9891	Catalogs.		274	
EC KMC	MSI Electronics Inc. 116-06 Myrtle Ave. Richmond Hill, N.Y. (212) 441-6420	Data sheets. Catalogs.		275	
	Mallory Semiconductor Co. 424 S. Madison St. DuQuoin, III. 62832 (618) 542-2154	Data sheets, Catalogs. Application notes. Article reprints. Data manuals. Customer applications service. Design aids.		276	
MEP	Mepco, Inc. Columbia Road Morristown, N.J. 07960 (201) 539-2000	Data sheets.			277
	MicroSemiconductor Corp. 11250 Playa Court Culver City, Cal. 90230 (213) 391-8271	Data sheets, Catalogs, Application notes, Article reprints, Customer applications service, Design aids,		278	
	Micro State Electronics Corp. Subsidiary of Raytheon Co. 152 Floral Ave. Murray Hill, N.J. 07971 (201) 464-3000	Data sheets. Catalogs. Application notes. Article reprints.		279	
	Microwave Associates Northwest Industrial Park Burlington, Mass. 01803 (617) 272-3000	Data sheets.		280	
MO	Motorola Semiconductor Products, Inc. 5005 E. McDowell Road Phoenix, Ariz. 85008 (602) 273-6900	Data sheets. Short form catalogs. Application notes.	281	282	283

Code	Company	Type of Information Offered	Transisto	Diode	Micro-
	National Electronics Inc. Geneva, III. 60134 (312) 232-4300	Data sheets.		284	
NA	National Semiconductor Corp. Commerce Road Danbury, Conn. (203) 744-0060		*		*
NOR	Norden Div., United Aircraft Corp. Helen St. Norwalk, Conn. 06856 (203) 838-4471	Data sheets. Catalogs. Application notes. Article reprints. Customer applications service.			285
NUC	(312) 232-4300 National Semiconductor Corp. Commerce Road Danbury, Conn. (203) 744-0060 Norden Div., United Aircraft Corp Helen St. Norwalk, Conn. 06856 (203) 838-4471 C Nucleonic Products Co., Inc. Components and Devices Div. 3133 E. 12th St. Los Angeles, Calif. 90023 (213) 968-3464 Ohmite Manufacturing Co. 3601 Howard St. Skokie, III. 60076 (312) 675-2600 Philbrick Researches, Inc. Allied Drive at Route 128 Dedham, Mass. 02026 (617) 329-1600 Philco Corp. Church Road Lansdale, Pa. 19446 (215) 855-4681 Power Components, Inc. P.O. Box 421 Scottdale, Pa. 15683 (412) 887-6600 Radiation Inc. P.O. Box 37 Melbourne, Fla. 32901 (305) 723-1511 Radio Corp. of America Electronic Components & Devices 415 S. Fifth St. Harrison, N.J. 07029 (201) 485-3900 Raytheon Co.	Data sheets.	286	287	1
	3601 Howard St. Skokie, III. 60076			*	
Allied Drive at Route 128 Dedham, Mass. 02026		Data sheets. Catalogs. Application notes. Article reprints. Data manuals. Customer applications service.			288
PH	Church Road Lansdale, Pa. 19446	Data sheets. Short form catalogs. Application notes. Article reprints. Design aids.	289	290	291
	P.O. Box 421 Scottdale, Pa. 15683	Data sheets. Catalogs. Application notes. Customer applications service. Design aids.		292	
RAD	P.O. Box 37 Melbourne, Fla. 32901	Data sheets.		293	294
RCA	Electronic Components & Devices 415 S. Fifth St. Harrison, N.J. 07029	Catalogs.	295	296	
RA	Raytheon Co. Semiconductor Operation 350 Ellis St. Mountain View, Cal. 94041 (415) 968-9211		*	*	*
	Rectico Inc. 20 Village Park Road Cedar Grove, N.J. 07009 (201) 239-6464	Catalogs.		297	
	Saratoga Semiconductor Div. Espey Mfg. Corp. P.O. Box 422 Saratoga Springs, N.Y. (518) 584-4100	Data sheets.		298	
	Sarkes Tarzian, Inc. 415 N. College Ave. Bloomington, Ind. 47401 (812) 332-1435	Data sheets, Catalogs, Application notes, Data manuals, Customer applications service, Design aids,		299	
	Schauer Mfg. Corp. 4500 Alpine Ave. Cincinnati, Ohio 45242 (513) 791-3030	Catalogs. Application notes. Price lists.		300	

6 ELECTRONIC DESIGN

Show us where you can't afford to use silicon power and we'll show you the new Bendix B-5000. (25 watts at 2.5 amps, 10 volts and 100 °C.)



It costs under 40¢.*

New manufacturing and packaging techniques make the B-5000 possible. These techniques include new internal device element assembly, along with new-concept plastic molding operations. The result is a simple, low-cost, reliable silicon power transistor with no power compromise when mounted upon the normal heat sink.

B-5000's low cost opens up whole new application areas for you. Now you can afford to put silicon power to work in many industrial and consumer products. Lighting equipment, TV sets, audio amplifiers, appliance sensing amplifiers and industrial controls, to mention a few. Compare the cost of the Bendix® B-5000 with any other silicon power unit of equal rating. You'll discover significant savings.

B-5000 offers advances in size, weight and thermal resistance. Leads and collector strips are a highly conductive material, offering excellent solderability, strength and ability to withstand flex and pull. Plastic encapsulant offers outstanding insulation resistance, hermeticity, adhesion ability and high temperature characteristics. In no way does B-5000 compromise traditionally accepted reliability practices.

With B-5000 you can tailor mounting techniques to fit your needs exactly. Depending on heat sink, available space and degree of assembly line mechanization, B-5000 can be mounted in the fashion best suited to your operation. For example, B-5000 is readily adaptable to the newer assembly solder techniques without degradation.

B-5000 lends itself equally well to other commonly used production line techniques.

Electrical specifications

1	Charac-	I	.imit	S	Test Conditions						
1	teristic	Min.	Max.	Unit	VCB V	VCE	IC A	IB mA	°C		
	VCEO ICEO ICBO VBE hFE hFE VCE(s)	35 - - 30 20 -	- 10 1.5 1.2 250 - 1.2	V mA mA V — V	14	25 14 14 14	0.2 0.5 0.5 1.0 1.0	50	150		

Absolute maximum ratings

VCEO = 35 volts, IC = 3 amps, IB=1 amp, Tstg=-65 to 175°C, TJ=-65 to 150°C.

For complete information about the new Bendix B-5000 silicon power transistor, write to us in Holmdel, New Jersey.

Bendix Semiconductor Division

HOLMDEL, NEW JERSEY

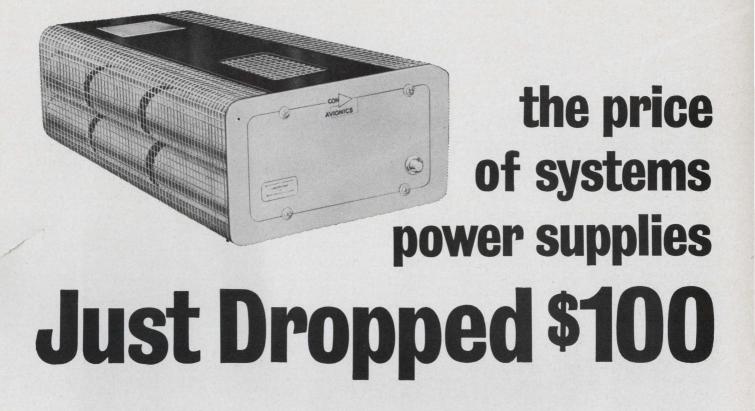


Code	Company	Type of Information Offered	Transistor	Diode	Micro-
	Semcor Div., Components Inc. 3540 W. Osborn Road Phoenix, Ariz. 85019 (602) 272-1341	Data sheets. Catalogs.		301	
	Semicon Inc. Sweetwater Ave. Bedford, Mass. 01730 (617) 275-8542	Data sheets. Catalogs.		302	
	Semiconductor Devices Inc. 875 W. 15th St. Newport Beach, Calif. 92663 (714) 642-5100	Data sheets. Catalogs.		303	
	Semiconductor Specialists Inc. 5700 W. North Ave. Chicago, III. 60639 (312) 622-8860	Data sheets. Catalogs. Customer applications service.		304	
	Semi-Elements Inc. Saxonburg Blvd. Saxonburg, Pa. 16056 (412) 352-1548	Catalogs.	T	305	
	Semtech Corp. 652 Mitchell Road Newbury Park, Cal. 91320 (213) 628-5392	Data sheets. Catalogs. Application notes. Data manuals. Customer applications service. Design aids.		306	
SA	Siemens America Inc. 230 Ferris Ave. White Plains, N.Y. 10603 (914) 948-3434	Data manuals.	307		
SIG	Signetics Corp. 811 E. Arques Ave. Sunnyvale, Calif. 94086 (408) 739-7700	Data sheets. Application notes. Article reprints.			308
STC	Silicon Transistor Corp. E. Gate Blvd. Garden City, N.Y. (516) 742-4100	Data sheets. Catalogs. Application notes. Customer applications service.	309	310	
SI	Siliconix Inc. 1140 W. Evelyn Ave. Sunnyvale, Calif. 94086 (408) 245-1000	Catalogs.	311		312
	Slater Electric Inc. 45 Sea Cliff Ave. Glen Cove, N.Y. (516) 671-7000	Data sheets, Catalogs, Application notes,		313	
	Solar Systems Inc. 8241 N. Kimball Ave. Skokie, III. 60076 (312) 676-2040	Data sheets. Catalogs. Application notes. Article reprints. Data manuals. Customer applications service.		314	
SSP	Solid State Products Inc. One Pingree St. Salem, Mass. 01970 (617) 745-2900	Data sheets. Catalogs. Application notes. Customer applications service.	315	316	
SOL	Solitron Devices Inc. 1177 Blue Heron Blvd. Riviera Beach, Fla. 33404 (301) 848-4311	Data sheets. Short form catalogs. Data manuals.	317	318	
SSD	Sperry Semiconductor 380 Main Ave. Norwalk, Conn. 06852 (203) 847-3851	Data sheets. Catalogs.	319		
SPR	Sprague Electric Co. 491 Marshall St. North Adams, Mass. 01247 (413) 664-4411	Data sheets. Application notes. Short form catalog.	320		321

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Code	Company	Type of Information Offered	Transisto	Diode	Micro-
SW	Stewart-Warner Microcircuits Inc. 730 E. Evelyn Ave. Sunnyvale, Calif. 94086 (408) 245-9200	Data sheets. Catalogs. Application notes. Article reprints. Customer applications service.			322
SY	Sylvania Electric Prod. 100 Sylvan Road Woburn, Mass. 01801 (617) 933-3500	Data sheets. Catalogs. Application notes. Customer applications service. Design aids.	323	324	325
	Syntron Company 283 Lexington Ave. Homer City, Pa. 15748 (412) 479-8011	Data sheets. Catalogs.		326	
TRWS	TRW Semiconductors Inc. 14520 Aviation Blvd. Lawndale, Calif. 90260 (213) 679-4561	Data sheets. Article reprints. Short form catalog.	327	328	4
TI -	Texas Instruments Inc. P.O. Box 5012 Dallas, Tex. 75222 (214) 235-3111	Data sheets. Catalogs. Application notes. Customer applications service.	329	330	331
TR	Transitron Electronic Corp. 168 Albion St. Wakefield, Mass. 01881 (617) 245-4500	Short form catalog.	332	333	334
	Trio Laboratories 80 DuPont St. Plainview, N.Y. 11803 (516) 681-0400	Data sheets. Application notes. Customer applications service.		335	
UC	Union Carbide Electronics 365 Middlefield Road Mountain View, Calif. 94041 (415) 961-3300	Data sheets. Catalogs. Application notes. Customer applications service. Design aids.	336		
	Unitrode Corp. 580 Pleasant St. Watertown, Mass. 02172 (617) 926-0404	Data sheets. Catalogs. Data manuals. Customer applications service. Samples. Test reports.		337	
TRWS TI TR VAR	Vactec Inc. 2423 Northline Industrial Blvd. Maryland Heights, Mo. 63045 (314) 432-4200	Data sheets.		338	
	Varian/Bomac Div. Beverly, Mass. 01915 (617) 922-6000	Data sheets. Catalogs. Application notes. Customer applications service. Design aids.		339	
VAR	Varo Inc., Special Products Div. 2201 Walnut St. Garland, Tex. 75040 (214) 276-6141	Data sheets. Catalogs. Article reprints. Design aids.		340	341
VEC	Vector Solid State Labs. Southampton, Pa. 18966 (215) 357-7600		*		
	Western Semiconductors Inc. 2200 Fairview St. Santa Ana, Calif. 92704 (714) 546-2250	Data sheets. Catalogs. Application notes. Customer applications service. Design aids.		343	
WH	Westinghouse Electric Corp. Molecular Electronics Div. Box 7377 Elkridge, Md. 21227 (301) 796-3666	Data sheets. Short form catalog.			344
WH	Westinghouse Electric Corp. Semiconductor Div. Youngwood, Pa. 15697 (412) 925-7272	Data sheets. Catalogs. Application notes. Article reprints. Design aids. Short form catalog.	345	346	

ELECTRONIC DESIGN



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PARTIAL SPECIFICATIONS

Input: 105-125 VAC, 47-63 cps

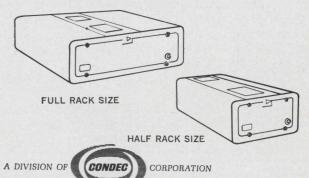
Regulation: (Line and load combined) $\pm 0.05\%$

Ripple: 1 mv RMS max.

Response time: 25 microseconds Temperature Coefficient: 0.015%/°C or 18 mv/°C., whichever is higher

Temperature: 75°C max.

The entire voltage range between 5.5 vdc and 51.0 vdc is covered in twenty-six models. Currents range from 8.0 amps to 46.0 amps. Wattages from 104.5 to 816.



ON READER-SERVICE CARD CIRCLE 5

Select the best transistor for the job by knowing which parameters govern for a given application. Here is the lowdown–from dc to RF and low-level thru large signal.

Modern bipolar transistors, unlike first-generation types (devices generally numbered below 2N700), have been specifically tailored to achieve optimum performance in certain applications. The key to transistor selection, then, lies in understanding and consulting the parameters which reflect a transistor's suitability for any particular application.

Here is a master chart which shows the governing parameters according to major application categories. It embraces small- and large-signal amplifiers, low- and high-speed low-level switching circuits, power switching networks and RF power amplifiers. The frequency range runs from dc to the gigahertz region.

Application categories narrow the search

Simply stated, the best transistor for an application is one which performs the intended function at lowest cost. Years ago, when nearly all transistors were made by an alloy process, differences between types could be predicted quite readily. Compromises were inevitable; the general trade-off was between frequency response and power-handling ability.

For a time, the dream of a universal transistor was entertained with the advent of mesa, planar and annular types of transistors. But the vision never materialized because with each technological advance it was found that transistors tailored to very specialized applications could be designed. These devices enabled performance in these applications to exceed by far all prior expectations.

To narrow the search for the transistor best suited to your application, a key parameter chart (see table) has been developed. The chart is applicable to the majority of available devices, including modern ones made by mesa or passivated technologies as well as older types made by alloy and grown processes.

The following definitions delineate the application categories.

■ Small-signal amplifiers to 3 Mhz. These devices handle small amounts of power, and they need

only have a limited frequency response. Operation is small-signal, that is, no large excursions of collector current are required, although collector-voltage swings may be large.

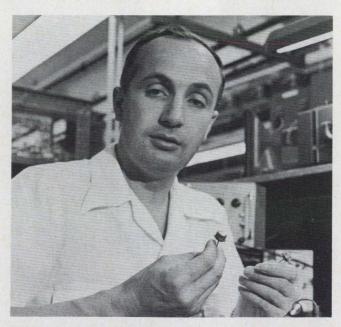
• Small-signal amplifiers above 30 MHz. These devices are similar to those above but are primarily intended for RF applications. There are some differences in the significant characteristics, particularly in gain, noise and agc.

■ Low level, low-speed switching and large-signal drivers. These cover switching speeds or amplification at frequencies below 1 MHz. They are generally of the same type as those in the first category, but additional specifications such as saturation voltages and response times are needed to define switching and large-signal performance.

■ Low-level, high-speed switching. Devices in this group are typified by a high f_T value (> 50 MHz, generally) and a low storage time.

• Large-signal amplifiers and power switching. Representative devices have a dissipation figure in excess of five watts at a 25°C case temperature.

• RF power amplifiers. Devices in this category



"Why settle for second-best?" Pick the optimum transistor type for your application by using author Roehr's guide to distinguishing between bipolar devices. It shows where and why transistors can and should be used.

William D. Roehr, Manager, Device Characterization Section, Applications Engineering, Motorola Semiconductor Products Inc., Phoenix, Ariz.

are especially designed for use as power amplifiers and oscillators at frequencies exceeding 10 MHz.

Gain: major factor in small-signal amplifiers

In small-signal amplification to 30 MHz, the primary characteristic of the amplifier is the power gain of the circuit. The power gain of an amplifier-operated common-emitter with no circuit feedback is easily determined from the transistor h parameters:

$$G = \frac{R_L h_{fe}^2}{(1 + h_{oe} R_L) (h_{ie} + \Delta h R_L)}, \qquad (1)$$

where R_L is the load resistance, h_{fe} the small-signal current gain (β) , h_{oe} the input admittance and h_{ie} the input impedance. Note that Δh is the determinant of the $h_{ie}-h_{fe}-h_{re}-h_{oe}$ matrix where h_{re} is the voltage feedback ratio. In many cases $R_L << h_{oe}$, so that Δh and gain may be approximated by

$$G = \frac{h_{fe}^2 R_L}{h_{ie}}. (2)$$

At low frequencies, input impedance h_{ie} may be written as $r'_b + h_{fe} r_e$, so that Eq. 2 may be further simplified to

$$G = h_{fe} \left[\frac{R_L}{r_e + (r'_b/h_{fe})} \right], \tag{3}$$

where r'_b is the transistor base resistance, and r_e the transistor dynamic emitter resistance. A transistor stage has a power gain equal to the product of a current gain and a voltage gain. Parameter h_{fe} establishes the current gain and the resistances (primarily the R_L/r_e ratio) determine the voltage gain.

The actual amplifier design can proceed once

the h parameters as a function of the operating point and some data on their inter-relationships are known. This information is usually found on the curves of a transistor data sheet.

Frequency response: a figure of merit

Second in importance only to gain in small-signal amplifiers is the frequency response. Here the gain-bandwidth frequency (f_T) is of prime interest.³ It serves as a very useful figure of merit.

To calculate circuit cutoff-frequency, the capacitance from base to collector (C_{ob}) must also be considered. For a common-emitter amplifier without degeneration, the response will be down 3 dB at the critical frequency given by

$$f_c \approx \frac{f_T/h_{fe}}{2 \pi f_T R_L C_{ob}}. \tag{4}$$

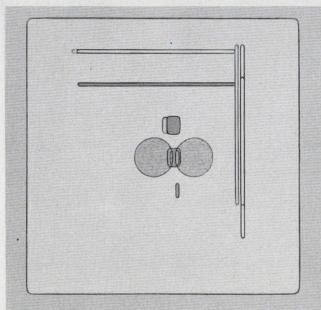
Older specification sheets generally use the term "beta-cutoff frequency," $f_{\alpha e}$, which is related to f_T by

 $f_{\alpha e} \approx f_T/h_{fe}.$ (5)

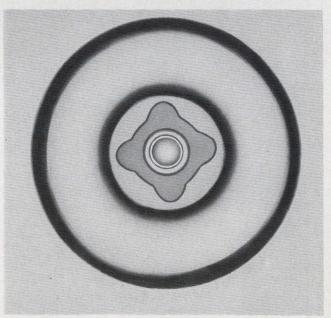
In the front ends of preamplifiers, the noise figure is all-important. Noise will be lowest for transistors having high h_{fe} and low r'_b values. Designing for low noise is usually quite involved, but helpful data sheet design curves are usually supplied. If it is not specified, assume that the transistor will usually be too high to be satisfactory for first-stage preamplifier operation, particularly when low frequencies are to be handled.

Aside from gain, frequency response and noise, there are a number of other, in general, secondary parameters that must be considered.

For linear operation, the available voltage swing must generally be confined. This avoids



This micropower switching transistor geometry is the 2N3493 device (Motorola). Featuring input and output capacitances of 0.7 pF, the transistor itself is in the rectangular-shaped overlap area between the circles.



A ring-dot geometry is exhibited by the 2N3783 bipolar transistor. Suitable for very low-noise RF amplification, this Motorola device has a maximum noise of only 2.2 dB at 200 MHz. The yolk-colored pattern is the base area.

distortion due to saturation in the low-voltage region and avalanche effects in the high-voltage area. The guideline to follow—since linearity is seldom specified—is to take the specified value of $V_{\rm BE}$ and nine-tenths of $V_{\rm CEO}$ as suitable limits for load-line excursions.

Even though small-signal amplifiers dissipate low power, the power-dissipation rating at ambient temperature and the maximum junction-temperature rating deserve some attention. In addition, although the $I_{\it CBO}$ leakage current is negligible in modern silicon transistors, it is large enough to cause stability problems in germanium types; where it, too, must be taken into account. In all transistors, the variation of base-emitter voltage and current gain as a function of temperature directly affects stability, although $V_{\it BE}$ and $h_{\it fe}$ were neglected in older treatments of the subject because the effect of $I_{\it CBO}$ was so much greater.

Devices classified as general purpose transistors will perform best in audio and video amplifying applications. In general, the best present types are silicon pnp passivated units, as they have the flatest curve of h_{fe} vs I_c and the lowest noise.

Engineers occasionally stretch a point in their search for a universal device. They may use a transistor which has been optimized for some other function in a small-signal amplifier application, just because the device is handy, or economical in large quantities. This may be foolhardy. For example, both silicon and germanium transistors intended for high-speed switching or RF amplification are poor choices as general-purpose devices. The switches, if made of silicon, will be gold-diffused to reduce storage time in saturatedmode switching service. This manufacturing practice causes the h_{fe} to be low and to fall off at low current, and also produces high leakage currents and high noise. A germanium-type switch is a poor choice because of low voltage-ratings and relatively high leakage currents. Similarly, the RF device will exhibit low gain at low frequencies and its h_{ef} is often very sensitive to changes in I_c and/ or VCE.

Oscillation frequency index of RF performance

RF small-signal amplifier applications require a new look at the gain and frequency parameters. The characteristics of importance in the RF region are in general quite different from those in the audio realm. Here too, gain is important, but the best indicator of it in the high-frequency region above the beta-cutoff frequency $f_{\alpha e}$ is f_{max} , the

Key parameters based on application

		100	Req	uired s	pecification	on ratings				CI	naracteri	stics lim	its		
Device types	Use category	Pc	P _A	Т	V _{CBO}	V _{CEO} or *V _{CES}	V _{EBO}	f _T or *f _{max}	C _{ob} or *C _{re}	h _{FE} or *h _{fe}	SV _{CE}	Noise fig.	Edge of sat	ts	Func- tional test
Alloy (GPA or GPS) Grown, mesa Planar Annular (no gold) (standard diffusion)	Small-signal amplifiers (to 30 MHz)		Х	X		Х		X	X	X*		x	X		-
Drift, mesa Planar Annular (RF diffusion)	Small-signal amplifiers (above 30 MHz)		X	Х		Х		X*	X*			X			G _e ,
Alloy, grown (no gold) Mesa Planar Annular	Low-level, low- speed switching (to 1.0 MHz); Large-signal drivers (below 30 MHz)		Х	X	х	X	х	X	Х	X	х		X	X	_ 1
Mesa gold-doped Planar or low-voltage (standard diffusion)	Low-level, high- speed switching (above 1.0 MHz)		Х	X	X	X	X	X	X	х	X		X	х	-
All power types with standard base diffusion	Large-signal amplifiers; Power-switching (below 10 MHz)	X		Х	х	X	Х	X	Х	x	X		Х	X	-
RF types only	Power-class amplifiers; Oscillators (above 10 MHz)	X		X		X*			X		X				G _e , P _{out}

maximum frequency of oscillation.6

The power gain at high frequencies for practical amplifiers is given as

$$G_e \approx \frac{f_T}{8 \pi f^2 r'_b C_{re}},$$
 (6)

where f_T is the gain-bandwidth product, f the frequency of operation, r'_b the base-spreading resistance and C_{re} the collector-base feedback capacity. The maximum frequency of oscillation, f_{max} , may be found by solving Eq. 6 for the frequency where power gain is unity. This yields

$$f_{max} \approx \sqrt{\frac{f_T}{8 \pi r'_b C_{re}}}.$$
 (7)

Note that power gain will increase at the approximate rate of 6 dB/octave as circuit operation is shifted down in frequency from f_{max} . Precise calculations can be made by using the two-port admittance parameters provided on the modern data sheet.

Once again, for the input stages of a system, noise figure is important. As with audio amplifier types, devices that do not have a specified noise figure will probably not be suitable for front-end operation at vhf and uhf.

Agc is a bias factor

RF devices generally exhibit a maximum gain when operated at certain bias conditions. Many transistors are designed to have special automatic gain control (agc) characteristics, so that gain decreases at a certain rate in relation to changes in the dc bias.

The gain may be reduced by decreasing the collector current (reverse agc), or increasing the collector current (forward agc). All transistors are capable of reverse-agc operation, whereas a forward agc characteristic is obtained only by special device design. Forward-agc operation is suitable only at frequencies above $f_{\alpha e}$; reverse agc may be used at any frequency. Forward agc has the advantage of an increasing signal-handling capability with rising input signal. This agc information is usually supplied for devices which are designed for particular use as gain-controlled amplifiers.

Other characteristics to be considered include the breakdown-voltage rating, $V_{\rm CEO}$, because it comes into play when choosing power supply voltages, and allowable output-voltage swings. Ambient-temperature power rating and the junction-temperature limit are of only passing interest. This is because RF applications are typified by low power-dissipation figures. Functional tests of gain and noise, as specified on some data sheets, show the optimum operating point and are an excellent guide to whether the device will be suitable for a given application.

As for the matter of "universality," the RF device is most emphatically a special product. General-purpose and switching transistors are not nearly as suitable in RF applications. In general,

the gain of these units will be very low, they will be unstable, and they will exhibit high noise.

Saturation, dc modes set switching stage

In low-level, low-frequency (≤ 1 MHz) switching, many of the characteristics specified for most modern devices must be weighed. The same type of transistor that makes a good audio amplifier may very well serve as a good switch.

Here, specifications additional to the audio figures are required. Of primary importance in a switching system is the gain of the stage which approaches the dc gain (h_{FE}) . Also, because most devices operate in a saturated mode, the saturation voltage is of considerable interest. It sets a system-voltage level and largely determines the power dissipation.

Finally, the remaining set of major parameters is the switching times.⁸ Included here is the storage time, for in the case of the older, alloy-junction devices, it can be lengthy. Nearly all modern types of transistors, however, have storage times which are quite small by comparison; they are therefore suitable for low-speed switching circuits. It is nonetheless desirable to have a storage time (t_s) , specification, which is approximated by

$$t_s = \tau_s \ln \frac{I_{B1} + I_{B2}}{(I_c/h_{FE} + I_{B2})}, \tag{8}$$

where τ_s is the storage-time time-constant, I_{B1} the turn-on base current, I_{B2} the turn-off base current, I_C the collector current and h_{FE} the dc current gain. Equation 8 is helpful in estimating storage time at a point other than the one specified on the data sheet. For alloy devices, Eq. 8 holds quite well; for modern devices, it is found that τ_s varies somewhat with I_C . In the latter case, Eq. 8 may result in an error of 2:1 and therefore should not be used indiscriminately.

Another figure of merit is the sum of the rise and fall times. An index of the rise-and-fall-time values can be obtained from f_T and C_{ob} . Parameter f_T predominates in the rise-time equation in the high-current region, while output capacitance C_{ob} is paramount in the low-current region. To predict rise time, t_r , both parameters must be known and used in:

$$t_r \approx \left(\frac{1}{2 \pi f_T} + R_L C_{ob}\right) \left(\frac{I_C/I_{B1}}{1 - I_C/2 I_{B1} h_{FE}}\right). \quad (9)$$

In Eq. 9 f_T is the gain-bandwidth product, R_L the load resistance, C_{ob} the collector-base capacitance, I_C the collector current, I_{B1} the base current and h_{FE} the dc current gain.

Load line control is essential

The expression is reasonably accurate providing that $I_c/I_{BI} < h_{FE}/2$. In applying it, the I_{BI} value must approximate a step of current, R_L should be a pure resistor and the values of f_T and C_{ob} must be averaged over the load line used.

The voltage breakdown rating, $V_{\it CEO}$, usually proves to be the best indicator of an upper voltage limit. But in many cases, careful control of the load line and the reverse bias placed on the transistor makes it possible to switch voltages up to the $V_{\it CBO}$ rating.⁹

For switching applications such as multivibrators and flip-flops, where capacitors are used in the base-coupling circuit, the V_{EBO} rating must be known, as it is quite easy to exceed this limit inadvertently.

The rated dissipation at ambient temperature and the maximum junction-temperature limit rate attention, but are not of prime importance, because the power dissipated here is fairly small.

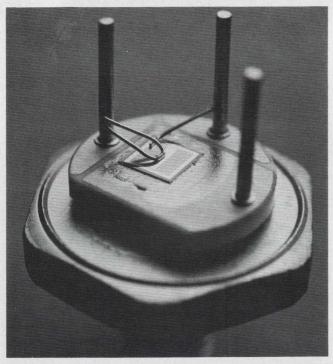
The leakage currents of germanium and silicon devices may be a selection factor. In today's silicon transistors they are so low that they are not of design significance. On the other hand, the leakage of germanium devices may prove troublesome.

Silicon transistors are generally preferable to germanium types in switching applications because the former have a higher $V_{\rm BE}$ turn-on voltage. This and their lower leakage currents make it easier to maintain the cut-off state.

Storage time a key in high-speed switching

The characteristics of importance to high-speed switching applications are essentially the same as those in the previous group. But there is greater emphasis on the storage-time specifications, since they prove to be a primary limit on how fast a logic system can operate.

To achieve low storage time, the recommended devices are low-voltage germanium or gold-doped silicon units. These transistors are generally un-



This power transistor features an isolated collector. Shown before being sealed, this semiconductor type (2N1724) unit comes in a TO-61 package.

suitable for applications other than switching. Silicon npn types achieve the fastest switching.

Designers are sometimes tempted to use an RF transistor in a switching application. The results are disappointing, for RF devices have low $V_{\it EBO}$ ratings, low $h_{\it FE}$ values, high storage times and poor saturation characteristics.

Power rates high in large-signal amplifiers

In large-signal amplification, large amounts of power are handled and the power rating of the transistor at a specified case temperature becomes of paramount interest. The voltage which it can tolerated, as indicated primarily by the $BV_{\it CEO}$ rating, is also of great importance. The other voltages normally mentioned on data sheets generally do not greatly affect these applications.

In such devices, the edge of the saturation region, as evidenced by the knee in the collector V-I curve is significant. This is particularly so for the linear power amplifier, as it is obviously desirable to handle current peaks and voltage excursions as close to the saturation region as possible for maximum efficiency. Edge of saturation information can often be obtained from data sheet curves. In power transistors, saturation will often occur when $V_{CE} > V_{BE}$.

occur when $V_{\it CE} > V_{\it BE}$. These power units are also used in power-switching, where many of the characteristics that are of consequence are the same parameters that govern in low-level applications. In this category, storage time may also limit the speed at which switching can be handled, although speed itself is usually not of primary importance.

Rise time at high currents is a major interest, but because of the current range over which these devices are switched, the use of f_T measured at a single point does not correlate with measured rise time if fitted to Eq. 9, and the rise-time specifications and curves must be used. Gain (h_{FE}) matters because efficiency is a prime consideration, and so too does saturation voltage because of the large currents usually handled. The product of the current and saturation voltage largely determines the power dissipation and dictates the requirements for the heat dissipator.

Current excursions modify frequency response

A common denominator for both large-signal-amplification and power-switching applications is frequency response. The gain-bandwidth frequency (f_T) serves as an indicator of amplifier high-frequency response, but as with switching service, the amplifier's large current excursions cause discrepancies. When attempting to calculate frequency response, Miller effect due to C_{ob} should be considered as well as f_T .

Generally, better amplifier performance predictions can be obtained from proper use of the transistor switching data. If rise-time data is plotted as a function of I_c with V_{cE} as a parameter (under the condition $I_c/I_{B1} << h_{FE}$), a large signal cutoff frequency can be found from

$$f_{A} = \frac{I_{C}}{2\pi t_{r} h_{FE} I_{B1}}$$
 (10)

In Eq. 10, f_A is the large-signal common-emitter cut-off frequency and I_c the ON collector current. Parameter t_r is the rise time obtained from switching data at the collector current (I_c) and voltage swing of interest. Note that $V_{\scriptscriptstyle CE}$ of the switching test is the same as ΔV_{CE} in amplifiers, and $I_{c(on)}$ of the switching test corresponds to $I_{C(PK)}$ in amplifiers; h_{FE} is the transistor dc current gain and I_{B1} is the turn-on base current used in the switching test.

Flat curves of h_{FE} vs I_c are desirable for silicon transistors, as they are commonly driven from high-impedance sources to obtain the best thermal stability and the lowest distortion. For germanium power transistors, a low-impedance drive circuit is required to achieve the same ends, so that a flat curve of transconductance vs collector current is needed.10

An extremely important characteristic of power devices is the safe operating area. 11 Data are usually presented in graphic form showing permissible regions of V_{CE} - I_C operation as a function of time. Unfortunately, safe area does not correlate very well with the power ratings based upon thermal resistance. All the same, safe area, not power rating, is more often than not the arbiter of power-handling ability, and therefore is the prime concern.

Functional tests guide RF operation

RF operation creates conditions such that conventional parameters simply give no indication of a particular transistor's suitability. The only way to select devices, then, is to refer to the functional test on the manufacturer's data sheet. Here you will find the power gain at a given power output under the optimum conditions for which the devices were designed.

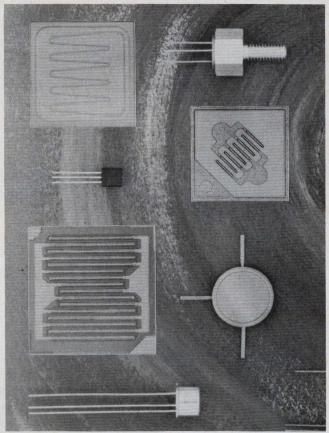
Bear in mind that the BV_{CES} voltage rating has proved to be the most useful single voltage rating for RF power transistors. As in low-frequency power applications, the edge of saturation is significant and so is safe area information. Secondary considerations are the maximum temperature rating and 25°C case power-dissipation rating. When designing the tuning circuit, output capacitance C_{ob} must be known.

Sewing up the tailored device choice

A theme of this discussion has been that there is no universal transistor. It is wisest to select transistors with specifications tailored by the manufacturer to a given application. 12

It is found, for example, that devices intended for high-speed, low-level saturated switching service possess very high noise figures and very low gain as audio-frequency amplifiers. Germanium switches, made from low-resistivity material to achieve low storage time, similarly should not be used indiscriminately in audio amplifiers.

Devices intended for RF applications are de-



Pick the right device! When faced with a number of transistor geometries, cans, etc., to choose from, use the key parameters as a guide to application.

signed to have very low base-spreading resistances. For this, a diffusion profile in the base is made to have an average low resistivity. As a result, the input capacity is rather high, the current gain very low, rendering this type of device unsuitable for audio and switching applications.

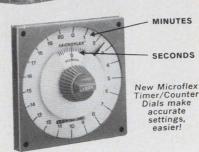
Conversely, the switching device, designed to have a high emitter-breakdown voltage and a low input capacitance, will have a high-base-spreading resistance. This results in low power gain and high noise when it is operated as an RF amplifier. In the power area, too, the same types of tradeoffs are evident. • •

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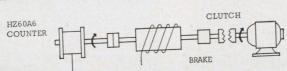




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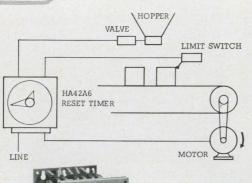
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25PS Medium Power Relay



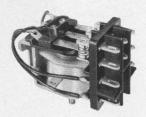
power-handling assignments to this workhorse. 25PS types carry loads to 20 amps. on a fast duty cycle in a breeze. UL listed. Features include: rugged 36" diameter silver cadmium oxide alloy contact; lower pull-in voltages (DC: 75% of nominal, AC: 76% of nominal); AC operating voltages 4 to 250, DC 1 to 130 in current ranges from .02 to 10 amp. For full technical information on this and other Eagle Signal general purpose and medium power relays, use the Reader Service Card, and circle number 96.

SPECIFICATIONS

- Contacts: SPDT
- Contact Rating: 20 amps. 115/230 VAC 60 cycle resistive • 1 HP @ 115/230 VAC motor-inductive
- Pull-in: 50 milliseconds max.
- Drop-out Speed: 30 milliseconds max.
- Size: 21/4" x 19/32" x 113/6"
- Weight: 3 ounces

RELAY DESIGNERS' RELAY

25AA Open Frame General Purpose Relay



Ask the man from E.A.G.L.E. to open his "showcase" of ideas for you. Many can help solve your process control problems. Want our complete catalog? Use the handy Reader Service Card, circle number 98 or write: Eagle Signal Division, E. W. Bliss Company, Federal Street, Davenport, Iowa 52803.

. . . and boy what a relay it is! Versatile, dependable, economical. You'll find hundreds of uses for these 5 or 10 amps., UL listed high-reliability types. Standard units have gold-plated contacts which permit longer shelf life. Other significant features include: lower pull-in voltages (DC: 70% of nominal, AC: 75% of nominal). AC operating voltages 0.5 to 250, DC 0.2 to 130 in current ranges from .005 to 10 amp. Detailed specifications on these and other Eagle Signal general purpose relays are given in a new technical bulletin. For your copy, use Reader Service Card, circle number 97.

SPECIFICATIONS

- Contacts: SPDT, DPDT, 3PDT
- Contact Rating: 5A and 10A @ 115 VAC●5A-1/10 HP @ 115 VAC, 1/6 HP @ 230 VAC●10A-1/6 HP @ 115 VAC, 1/3 HP @ 230 VAC
- Pull-in: 22 milliseconds average
- Drop-out Speed: 12 milliseconds average
- Size: 11/8" x 11/32" x 11/2"
- Weight: 2 ounces





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How to use the charts

A tint pairs the transistor type with the value of its key parameter for most applications in each transistor category. Devices are listed in order of increasing value of that key parameter. Note, however, that since various manufacturers may characterize their types differently, some "jumps" may take place in the sequence. Consider, for example, a type in the high-frequency category. Its key characteristic will be $f_{\alpha e}$ or f_T (values of f_T are preceded by a single asterisk). But $f_{\alpha e}$ is the frequency at which h_{fe} drops to 0.707 of its low-frequency value, and f_T is the gain-bandwidth product, or the product of h_{fe} and frequency at a point where h_{fe} is dropping by 6 dB per octave. Thus, f_T is about h_{fe} times greater than $f_{\alpha e}$ for a given type.

Under maximum ratings, manufacturers were asked to specify collector power dissipation at 25° C case temperature, this generally being the most meaningful single rating. The derating factor can then be used to estimate P_c for other operating temperatures.

Either $V_{\scriptscriptstyle CEO}$ or $V_{\scriptscriptstyle CEO}$ is listed as a maximum voltage rating. $V_{\scriptscriptstyle CEO}$ is related to collector-emitter diode breakdown and $V_{\scriptscriptstyle CEO}$ to collector-base diode breakdown. But bear in mind that many manufacturers' data sheets will list other important voltage ratings, such as $V_{\scriptscriptstyle CES}$ or $V_{\scriptscriptstyle CER}$.

Under characteristics, ELECTRONIC DESIGN asked manufacturers to supply typical values —maximums, minimums or spreads. Where deviations from this occur, they are noted.

Finally, a word of caution: the characteristics listed serve primarily as a guide and generally should not be used exclusively for direct comparison of types. This is because it is impossible to list the wide variety of test conditions under which characteristics have been measured. $V_{\rm CEO}$, for example, can differ considerably for comparable devices when measured at a collector current of 100 μ A in one case and 1 mA in another. The best bet is to consult the manufacturers' data sheets before making the final selection. Also, scan the articles that preface each listing section. Each article contains important information about parameter evaluation.

Key to Symbols

itey to o	/mbol3
$f_{lpha_{ m e}}$	= small-signal short-circuit forward
	current transfer ratio cutoff fre-
	quency (commont-emitter)
f ab	= small-signal short-circuit forward
	current transfer ratio cutoff frequen-
	cy (common-base)
f _T	= gain-bandwidth product
P _c	= collector power dissipation (average)
T _j	= junction temperature °C
mW/°C	= derating factor
V _{CEO}	= max collector voltage, collector to emitter, base open
V_{CBO}	= max collector voltage, collector to base, emitter open
I _c	= max collector current
I _p	= max collector current (peak)
\mathbf{h}_{fe}	= small-signal short-circuit forward
	current transfer ratio (common- emitter)
$h_{ ext{FE}}$	= dc short-circuit forward current transfer ratio (common-emitter)
I _{co}	= collector cutoff current (dc), emitter open
C _{oe}	= output capacitance (common emit ter)
C _{ob}	= output capacitance (common-base)
t _r	= rise time
t _s	= storage time
V _{CE(sat)}	= collector-to-emitter saturation volt-
g _m	age transconductance
V _P	= pinch-off voltage
DSS	= zero-bias drain current
BV _{DGO}	= drain-gate breakdown voltage with gate-source open-circuited
BV_{DGS}	= breakdown voltage from drain to
DGS	gate with drain shorted to source
Cis	= common source short-circuit input capacitance
N.F.	= noise figure
η	= intrinsic standoff ratio
l _{EO}	= max emitter reverse current
	= max peak point emitter current
$\mathbf{V}_{\mathrm{E(sat)}}$	= max emitter saturation voltage
$V_{ m EB2}$	= min emitter reverse voltage
V_{OB1}	= min base one peak pulse voltage





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capabilities with

 $P_{T} = 350 W @ 25 °C!$

		DESIG	ON LIMITS		PERFORMANCE SPECIFICATIONS							
	P _T	ВУсво	V _{CEO}	BV _{EBO}	h	FE	V _{BE} (sat)	V _{CE} (sat)	Гсво	f _T		
Туре	Watts	Volts	Volts	Volts			Volts	Volts	μΑ	MH		
Number	25°C							11111		MHz		
	Case	$I_c = 1mA$	$I_c = 0.2A$	$I_E = 1mA$	$I_c = 75A$	I _c =90A	$I_c = 50A$	$I_B = 5A$	V _{CB} = 60V	Charles A		
	Max.	Min.	Min.	Min.	Min.	Min.	Max.	Max.	Max.	Тур.		
MHT8920	350	80	60	8	10	5	2.0	1.5	10	20		
MHT8921	350	100	80	8	10	5	2.0	1.5	10	20		
MHT8922	350	120	100	8	10	5	2.0	1.5	10	20		
MHT8923	350	140	120	8	10	5	2.0	1.5	10	20		
	50°C Case	$I_c = 2mA$			I _c = 50A		I _c = 50A	, I _B = 10A	V _{CB} = RATED	MIN		
2N3149	300	80	80	10	10		2.5	1.5	2000	0.1		
2N3150	300	100	100	10	10	-	2.5	1.5	2000	0.1		
2N3151	300	150	150	10	10		2.5	1.5	2000	0.1		



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19

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Key to Transistor Types

	Construction	GD	Grown diffused
ΔΕ	Appular apitavial	GJ	Grown junction
AE	Annular epitaxial	GR	Rate grown
AJ	Alloy junction	MB	Meltback
AD	Alloy diffused	MD	Micro-alloy diffused base
DD	Double diffused	MS	Mesa
DG	Grown diffused	PE	Planar epitaxal
DJ	Diffused junction	PL	Planar
DM	Diffused mesa	SBT	Surface barrier
DDM	Double-diffused mesa	SP	Surface precision alloy
DP	Diffused planar	TDP	
DR	Drift		Triple-diffused planar
ED	Electro-chemical diffused-collector	PADT	Past alloy diffused technique
EM	Epitaxial mesa		Matariala
EP	Epitaxial		Materials
FA	Fused alloy	ge	germanium
FJ	Fused junction	si	silicon

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Manufacturers and their lines

Manufacturer .	Symbol	Audio A	High-Frequency HF	Power P	Low-Level LL	High-Level HL	Field-Effect FET	Unijunctio UJT
Amelco	AL	•	•	•	•	•	•	
Amperex	AMP	•	•	•	•	•		
Bendix	BE		•	•		•		
Burroughs	BU				•			
Continental Device	CDC	•	•	•	•	•		
Crystalonics	СТ	•	•	•			•	
Delco	DE			•		•		
Dickson	DIC -						•	
Electronic Transistor	ETC	•	•	•	•	•		
Fairchild	FA	•	•	•	•	•	•	
General Electric	GE	•	•	•	•	•		
General Instrument	GI	•	•	•	•	•	•	
General Micro-electronics	GME	•	•		•		•	
Hughes	HU				•	•	•	
ITT Semiconductors	ITT		•	•		•		
Industro Transistor	IND	•	•					
International Electronics	IEC	•	•					
KMC Semiconductor	KMC		•				•	427
KSC Semiconductor	KSC		•	•		•		
Lansdale	LAN	•	•	•	•			
Motorola	MO	•	•	•	•	•	•	•
National Semiconductor	NA	•	•	•	•	•		
Nucleonic Products	NUC	•	•	•	•	•		
Philco	PH		•		•			
Radio Corp. of America	RCA	•	•	•	•	•	•	
Raytheon	RA	•	•		•	•		
Siemens America	SA	•	•	•	•	•		
Silicon Transistor	STC		•	•		•		
Siliconix	SI						•	
Solid State Products	SSP		•	•		•		
Solitron	SOL			•				
Sperry Semiconductor	SSD	•	•		•			
Sprague	SPR	•	•	•	•	•		
Sylvania	SY	•	•	•	•	•		
Texas Instruments	TI	•	•	•	•	•	•	•
Transitron	TR	•	•	•	•	•		
TRW Semiconductors	TRWS	•	•	•		•	•	
Union Carbide	UC	•	•				•	
Vector	VEC		•	•	•			
Westinghouse	WH							

May 17, 1966 21

Audio and General Purpose

Mostly audio and general-purpose types handling less than one watt. Listed in order of increasing forward-current transfer ratio.

						MAX.	RATINGS			CHARACT	ERISTICS		
Cross Index Key	Type No.	Mfr.	Туре	h _{fe}	P _c (mW)	T _j (°C)	mW/°C	*VCBO (V)	I _c (mÅ)	Ι _{co} (μ A)	fae *fT (MHz)	Package Outline (TO-)	Remarks
A 1	2N1439 2N1223 NS-664 NS-668 2N927	NA SSD NA NA	pnp,A,si AJ pnp,A,si pnp,A,si pnp,A,si	5-12 6 7-22 7-22 8-22	400 250 400 150 150	200 175 175 175 175 200	2.25 1.67 2.5 1 .85	50 40 50 50 60	100 100 100 100 100	.025 0.1 1 1 .025		5 5 5 18 18	CT CT, SPR Industrial Type Industrial Type SPR
	2N935 2N938 2N1024 2N1025 2N1028	SSD SSD SSD SSD SSD	AJ AJ AJ AJ	*9 9 9 9	385 250 250 250 250	160 175 175 175 175 175	2.85 1.67 1.67 1.67 1.67	40 35 15 35 10	50 50 100 100 100	0.1 .025 .025 .025 .025	0.2 - 1 - -	18 18 5 5 5	CT, SPR CT, SPR AMP, CT, SPR AMP, CT, SPR CT, SPR
A 2	2N1154 2N1155 2N1156 2N1220 2N1222	TI TI TI SSD SSD	npn,si npn,si npn,si AJ AJ	9 9 9 *9	750 750 750 250 250	150 150 150 175 175	6 6 6 1.67 1.67	*50 *80 *120 25 25	60 50 40 100 100	5 5 5 0.1 0.1	1 1 1 1 1	- - - 5 5	TR, NA, ETC TR, NA, ETC TR, NA, ETC TR, NA, ETC CT, SPR CT, SPR
	2N1586 2N1587 2N1588 2N332A 2N1440	TI TI TI GE NA	npn,si npn,si npn,si npn,DG,si pnp,A,si	9 9 9 9-20 9-22	125 125 125 500 400	87.5 87.5 87.5 175 200	2 2 2 3.33 2.25	10 20 40 45 50	25 25 25 25 25 100	1 1 1 .5 .025	1 - 1 - 1	- - - 5 5	TR, ETC TR, ETC TR, ETC TR AMP, CT
A 3	2N2673 2N1394 2N1408 2N1643 2N1672A	GE GI GI CT GI	pnp,DG,si pnp,ge pnp,AJ,ge pnp,si npn,AJ,ge	9-22 10 *10 *10 *10	250 50 150 250 120	175 - 100 160 85	1.66 0.8 2 1.9 2	*60 *10 *50 25 *55	25 - - 50 -	.1 15 7.0 .001 25	- 1 - 2	46 - 5 5 5	МО
	BCZ12 2N925 2N470 2N471 2N472	AMP NA TR TR TR	pnp,AJ,si pnp,A,si npn,PL,si npn,PL,si npn,PL,si	10 10-24 10-25 10-25 10-25	250 150 200 200 200	150 200 175 175 175	2 .85 1.2 1.2 1.2	60 40 15 30 45	50 100 25 25 25 25	0.1 .025 .5 .5	1 - 8 8 8	1 18 5 5 5	SPR
A 4	2N472A 2N1082 2N102 2N117 2N332	TR TR SY TI TI	npn,PL,si npn,PL,si npn,AL,ge npn,si npn,si	10-25 *10-50 *10.5 12 12	200 200 1000 150 150	175 175 75 175 175	1.2 1.5 - 1 1	45 *25 *30 *45 *45	25 50 1500 25 25	.5 .5 500 2 2	8 17.2 - - -	5 5 13 - 5	TR GE; TR
	2N1474 2N1476 2N756 2N756A 2N923	SSD SSD NA NA NA	AJ AJ npn,DM,si npn,DM,si pnp,A,si	12 12 12-22 12-22 12-30	250 250 500 500 150	175 175 200 200 200	1.67 1.67 2.5 2.5 2.5	60 100 45 60 25	100 100 100 100 100	.050 0.2 0.2 0.1 .025	11111	5 5 18 18 18	CT, AMP, SPR CT, SPR TR TR SPR
A 5	NS-731 NS-733 2N1149 2N726 2N1248	NA NA TI TI TR	npn,DM,si npn,DM,si npn,si npn,si npn,PLE,si	12-55 12-55 12.3 15 *15	400 400 150 300 30	175 175 175 175 175 150	2.5 2.5 1 2 .24	15 30 *45 20 6	100 100 25 50 5	1 1 2 1 .01		18 18 - 18 5	Industrial Type Industrial Type TR GE
A.C.	2N1311 2N1655 2N2177 2N2178 2N2370	GI RA SSD SSD NA	npn,AJ,ge pnp,Si AJ AJ pnp,A,Si	*15 *15 *15 *15 *15 *15	120 250 100 100 200	85 160 175 175 200	2 1.85 .67 .67 1.0	*75 125 6 6 15	50 50 50 50 100	7.0 1.0 .005 .005 .005	1.5 .050 - - -	5 5 5 18 5	TI CT, SPR CT, SPR CT, SPR Low Level, Low Noise, AMP, CT, SPR
A 6	2N2372 2N2391 BCY30 BCY33	NA TI AMP AMP	pnp,A,si pnp,si pnp,AJ,si pnp,AJ,si	*15 15 15 15	150 300 250 250	200 175 150 150	1 2 2 2	15 20 *64 *32	100 50 100 100	.005 10 .1 .1	- - .25 .4	18 50 5 5	Low Level, Low Noise, CT, SPR
	BCZ13 2N529 NS-663 NS-667 MA885	AMP GI NA NA MO	pnp,AJ,si - pnp,A,si pnp,A,si pnp,AJ,ge	15 15-20 15-36 15-36 15-40	85 100 400 150 200	85 175 175 170	.9 2 2.5 1 2.67	*20 *15 50 50 *50	10 - 100 100 500	.01 5.0 1 1 15	1.5 2.5 - +0.5	- 5 5 18 5	Sub min case Industrial Type Industrial Type †fab
A 7	2N243 2N936 2N939 2N1026 2N1027	TI SSD SSD SSD SSD	npn,si AJ AJ AJ AJ	16 *18 18 18 18	750 385 250 250 250	150 160 175 175 175	6 2.85 1.67 1.67 1.67	*60 35 35 35 35 15	60 50 50 100 100	1 0.1 .025 .025 .025	-	- 18 18 5 5	TR, NA CT, SPR CT, SPR CT, SPR CT, SPR CT, SPR

						MAX.	RATINGS			CHARACT	ERISTICS		
Cross Index Key	Type No.	Mfr.	Туре	h _{fe} *h _{FE}	P _c (mW)	T _j (°C)	mW/°C	YCEO *VCBO (V)	I _c (mA)	Ι (μ A)	fae *fT (MHz)	Package Outline (TO-)	Remarks
Λ.0	2N1219 2N1221 2N1474A 2N1441 2N757	SSD SSD SSD NA NA	AJ AJ AJ pnp,A,si npn,DM,si	*18 18 18 18-36 18-40	250 250 250 400 500	175 175 175 200 200	1.67 1.67 1.67 2.25 2.5	25 25 60 35 45	100 100 100 100 100	0.1 0.1 .050 .025 0.2		5 5 5 5 18	SPR CT, SPR CT, SPR AMP, CT TR, GI
A 8	2N333A 2N2674 2N928 2N334A 2N758	GE GE NA GE NA	npn,DG,si npn,DG,si pnp,A,si npn,DG,si npn,DM,si	18-44 18-44 18-55 18-90 18-90	500 250 150 500 500	175 175 200 175 200	3.33 1.66 .85 3.33 2.5	45 *60 60 45 45	25 25 100 25 100	.5 .1 .025 .5 0.2	11 - - 12 -	5 46 18 5 18	TR SPR TR TR, GI
	2N758A 2N734 2N738 2N1273 2N1274	NA TI TI TI	npn,DM,si npn,si npn,si pnp,ge pnp,ge	18-90 20 20 20 20 20	500 500 500 150 150	200 175 175 85 85	2.5 3.33 3.33 2.5 2.5	60 60 80 *15 *25	100 50 50 150 150	0.1 1 1 14 14		18 18 18 5 5	GI TRWS, TR TR
A 9	2N1310 2N1312 2N1372 2N1373 2N1380	GI GI TI TI	npn,AJ,ge npn,AJ,ge pnp,ge pnp,ge pnp,ge	*20 *20 *20 *20 *20	120 120 250 250 250	85 85 100 100	2 2 3.3 3.3 3.3	*90 *50 *25 *45 *12	- 200 200 200	7 7 - - 14	1 2 - -	5 5 5 5 5	TI TI
	2N1381 2N1383 2N1445 2N1564 2N1572	TI TI TI TI	pnp,ge pnp,ge npn,si npn,si npn,si	20 20 *20 20 20 20	250 200 800 600 600	100 85 200 175 175	3.3 3.3 4.57 4	*25 *25 *120 60 80	200 200 750 50 50	14 14 10 1	11111	5 5 5 5 5	TRWS, TR
A 10	2N1672 2N2371	GI NA	npn,AJ,ge pnp,A,si	*20 *20	120 200	85 200	2 1.0	*40 15	100	25 .005	2 -	5 5	Low Level, Low Noise, AMP, CT,
	2N2373 2N3579	NA SSD	pnp,A,si pnp,EP	*20 *20	150 400	200 200	1 2.28	15 60	100 30	.005 0.05	80	18 46	Low Level, Low Noise, CT, SPR
	2N3877 2N3877A A130 A310 A311	GE GE AMP AMP AMP	npn,PL,si npn,PEP,si npn,PL,si npn,PL,si npn,PL,si	*20 min. *20 min. *20 *20 *20	200 200 360 300 300	100 100 200 175 175	2.67 2.67 2 2 2	70 85 *90 *135 *80	50 50 - -	0.5 0.5 - .5 .5	135 135 30 50 30	98 98 5 5 5	
A 11	BCY38 2N530 2N2042 2N2042A 2N926	AMP GI MO MO NA	pnp,AJ,si pnp,AJ,ge pnp,AJ,ge pnp,A,si	*20 20-25 *20-50 *20-50 20-55	120 100 200 200 200 150	150 85 100 100 200	2 2 *2.67 *2.67 .85	*32 *15 105 105 40	250 - 200 200 100	.1 5 10 10 .025	.45 3 - - -	5 5 5 18	TI TI SPR
	2N339A 2N340A 2N341A 2N118 2N333	TR TR TR TI TI	npn,PL,si npn,PL,si npn,PL,si npn,si npn,si	*20-80 *20-80 *20-80 24 24	250 250 250 250 150	175 175 175 175 175 175	3 3 3 1 1	60 85 125 *45 *45	150 150 150 25 25	1 1 1 2 2	10 10 10 - -	11 11 11 - 5	TR GE, TR
A 12	2N1150 2N924 NS-662 NS-666 2N330A	TI NA NA NA RA	npn,si pnp,A,si pnp,A,si npn,A,si pnp,si	24 24-60 24-60 24-60 25	150 150 400 150 380	175 200 175 175 160	1 .85 2.5 1 2-9	*45 25 40 40 ·30	25 100 100 100 50	2 .025 1 1 0.1	- - - - 0.05	- 18 5 18 5	TR Industrial Type Industrial Type SSD, AMP, CT
7	2N563 2N564 2N1589 2N1590 2N1591	GI GI TI TI	pnp,AJ,ge pnp,AJ,ge npn,si npn,si npn,si	25 25 25 25 25 25 25	150 120 125 125 125	85 85 87.5 87.5 87.5	2.5 2 2 2 2 2	*30 *30 10 20 40	300 300 25 25 25 25	5 5 1 1	0.8 0.8 - -	5 - - -	IND TR TR TR TR
A 13	2N1623 2N2304 2N2617 2N2831 BCY31	RA RA AMP SY AMP	pnp,si npn,PL,si pnp,si npn,PE,si pnp,AJ,si	*25 *25 *25 *25 *25 25	250 600 350 360 250	160 300 150 175 150	1.85 3-4 2 - 2	20 30 *25 *40 *64	50 250 50 200 100	1.0 .010 .001 .30	0.05 10 3 250 25	5 5 - 18 5	CT, SPR TRWS
	BCY34 SA2253 2N531 2N658 2N306	AMP AL GI TI SY	pnp,AJ,si npn,si - pnp,AJ,ge npn,AL,ge	25 *25 25-30 *25-80 *25-125	250 - 100 250 180	150 150 85 100 85	2 - 2 6.66	*32 *40 *15 12 *20	100 - - 1000	.1 .05 5.0 6 20	.6 - 3.5 - .600	5 5 5 5 22	
A 14	2N2860 2N279 2N662 2N727 2N1477	SY AMP TI TI SSD	npn,PE,si pnp,AJ,si pnp,AJ,ge npn,si AJ	*25-125 30 *30 30 30 30	200 125 250 300 250	175 75 100 175 175	2.5 6.66 2 1.67	*30 30 12 20 100	10 100 50 100	1 110 6 1 0.2	*1000 0.15 - - -	18 1 5 18 5	Low Noise CT, SPR

						MAX.	RATINGS			CHARACTE	RISTICS		
Cross Index Key	Type No.	Mfr.	Туре	h _{fe} *h _{FE}	P _c (mW)	T _j (°C)	mW/°C	V CEO *V CBO (V)	I _c (mÅ)	ι (μ Α)	fae *fT (MHz)	Package Outline (TO-)	Remarks
	2N1654 2N1656 2N2173 2N2173 2N2392	RA RA TI MO TI	pnp,si pnp,si pnp,ge pnp,ge pnp,si	*30 *30 *30 *30 30	250 250 240 240 300	160 160 100 100 175	1.85 1.85 3.2 3.2 2	80 125 15 15 20	50 50 750 750 750 50	1 1 10 10 10	.050 .050 - -	5 5 5 5 5	CT, SPR CT, SPR
A 15	2N2599A BCY39 BCZ14 2N532 2N1101	SSD AMP AMP GI SY	pnp,EP pnp,AJ,si pnp,AJ,si - npn,AL,ge	*30 *30 30 30-35 *30-60	400 120 85 100 180	200 150 - 85 85	2.28 2 .9 2	100 *69 *20 *15 *20	30 250 10 - 100	0.025 .1 .01 5 50	60 .85 1.5 4.0 .10	46 5 - 5 22	sub min case
	2N1102 2N1442 2N650 2N650A 2N653	SY NA MO MO	npn,AL,ge pnp,A,si pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	*30-60 30-65 30-70 30-70 30-70	180 400 200 200 200 200	85 200 100 100 100	2.25 2.67 2.67 2.67 2.67	*40 30 *45 *45 *30	100 100 500 500 250	50 .025 10 10 15	0.10 - - - 1	22 5 5 5 5	CT TI TI TI
A 16	2N1186 2N1191 MA881 MA886 2N2711	MO MO MO MO GE	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge npn,PL,si	30-70 30-70 30-70 30-70 30-90	200 200 200 200 200 200	100 100 100 100 100	2.67 2.67 2.67 2.67 2.67	*60 *40 *60 *50 18	500 200 500 500 100	10 15 10 15 .5	†0.75 †0.75	5 5 5 5 98	TI †fab †fab NUC
	2N2713 MPS2711 MPS2715 2N1051 2N1707	GE MO MO	npn,PEP,si npn,EP,si npn,EP,si npn,DD,si pnp,AJ,ge	*30-90 *30-90 *30-90 30-100 30-150	200 310 310 500 200	100 135 135 150 100	2.67 2.81 2.81 4 2.66	18 18 18 40 *30	200 100 25 100 400	0.5 0.5 0.5 .1 15	- - 4 †4	98 92 92 5. 5	Full line spread NA †fab
A 17	2N244 2N405 2N406 2N780 2N1010	TI RCA RCA TI RCA	npn,si pnp,AJ,ge pnp,AJ,ge npn,si npn,AJ,ge	32 35 35 *35 35	750 150 150 300 20	150 71 71 175 55	6 - - 2 -	*60 *20 *20 45 *10	60 35 35 50 2	1 14 14 0.01 10	0.65 0.65 - 2	- 40 1 18 1	TR, NA LAN AL LAN
	2N2389 BCY32 2N533 40234 AC 121	TI AMP GI RCA SA	npn,si pnp,AJ,si - npn,P,si pnp,AJ,ge	35 35 35-40 35-180 35-190	450 100 100 500 900	200 150 85 175 90	2.57 2 2.0 3.3 20	*75 *64 *15 18 20	500 50 - 100 300	0.01 - 5 0.5 (max) 5	4 4.5 *60 1.5	50 9 5 - 1	
A 18	2N2926 MPS2926 2N937 2N940 2N1469	GE MO SSD SSD SSD SSD	npn,PL,si npn,EP,si AJ AJ AJ	†35-470 35-470 *36 36 36	200 310 385 250 250	100 135 160 175 175	2.67 2.81 2.85 1.67 1.67	- 18 30 35 35	100 100 50 50 100	0.5 0.5 0.1 .025 .025	111111	18 92 18 18 5	NUC, † Full line spread, GME CT, SPR CT, SPR CT, SPR
	2N1475 2N759 2N759A 2N335A 2N2675	SSD NA NA GE GE	AJ npn,DM,si npn,DM,si npn,DG,si npn,DG,si	36 36-90 36-90 37-90 37-90	250 500 500 500 250	175 200 200 175 175	1.67 2.5 2.5 3.33 1.66	60 45 60 45 *60	100 100 100 25 25	.050 0.2 0.1 .5		5 18 18 5 46	AMP, CT, SPR TR, GI, TI SPR, GI, TI TR
A 19	2N334 2N1151 2N735 2N739 2N934	TI TI TI TI RCA	npn,si npn,si npn,si npn,si pnp,MS,ge	39 39 40 40 *40	150 150 500 500 150	175 175 175 175 175	1 1 3,33 3,33 -	*45 *45 60 80 13	25 25 50 50	2 2 1 1		5 - 18 18 18	GE, TR TR TRWS, TR, TR,
A 00	2N1370 2N1371 2N1374 2N1375 2N1382	TI TI TI TI TI	pnp,ge pnp,ge pnp,si pnp,ge pnp,ge	40 40 40 40 40	150 150 250 250 200	85 85 100 100 85	2.5 2.5 3.3 3.3 3.3	25 45 *25 *45 *25	150 150 200 200 200 200	14 14 7 7 14	-	5 5 5 5 5	
A 20	2N1413 2N1565 2N1573 2N1622 2N2868	GE TI TI GI GE	pnp,AJ,ge npn,si npn,AJ,ge npn,AJ,si	*40 40 40 *40 40	200 600 600 120 2800	85 175 175 85 200	3.33 4 4 2 16	*35 60 80 *90 40	200 50 50 - 1000	12 1 1 7.0 .010	- - 1 130	5 5 5 5 5	TRWS, TR TR
Λοι	2N2909 2N3064 2N3065 2N3580 A306	GE CT CT SSD AMP	pnp,PE,si pnp,si pnp,si pnp,EP npn,PL,si	40 40 40 *40 40	2800 400 400 400 400 360	200 200 200 200 200 200	16 2.3 2.3 2.28 2	40 *110 110 60 *25	1000 100 100 30 -	.010 .01 .01 0.05 .01	130 - - 80 100	46 46 46 46 18	
A 21	BCY11 BCY12 ME900 SFT325 2N480A	AMP AMP AMP NUC TR	pnp,AJ,si pnp,AJ,si npn,PL,si pnp,ge npn,PL,si	40 40 40 *40 40-100	310 310 360 500 200	150 150 200 85 175	2.5 2.5 2 - 1.2	60 32 *40 *32 45	500 500 - 500 25	0.1 0.1 .01 30 .5	1.5 1.5 100 - 20	1 1 18 1 5	GE

						MAX.	RATINGS			CHARACT	TERISTICS		
Cross Index Key	Type No.	Mfr.	Туре	h _{fe} *h _{FE}	P _c (mW)	T _j (°C)	mW/°C	*VCEO *VCBO (V)	I _c (mA)	Ι (μ A)	fae *fT (MHz)	Package Outline (TO-)	Remarks
	2N2043 2N2043A 2N659 2N2244 2N2247	MO MO TI NA NA	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge npn,DM,si npn,DM,si	*40-100 *40-100 *40-110 40-120 40-120	200 200 250 500 500	100 100 100 200 200	2.67 2.67 6.66 2.5 2.5	105 105 12 20 45	200 200 1000 100 100	10 10 6 .01	0.75 0.75 - -	5 5 5 18 18	TI TI Low Level
A 22	2N2250 2N2253 2N4030 2N4031 NS-732	NA NA FA FA NA	npn,DM,si npn,DM,si pnp,PE,si pnp,PE,si npn,DM,si	40-120 40-120 40-120 40-120 40-125	500 500 800 800 400	200 200 200 200 200 175	2.5 7.5 22.8 22.8 2.5	20 45 60 80 15	100 100 - - 100	.01 .01 .2 .2	100 150	18 18 5 5 18	Low Noise, CDC Low Noise, CDC, AMP
A 23	NS-734 2N1192 2N3691 OC79 2N104	NA MO FA AMP RCA	npn,DM,si pnp,AJ,ge npn,PL,si pnp,PADT,ge pnp,AJ,ge	40-125 40-135 *40-160 42 44	400 200 625 0.55 150	175 100 150 75 70	2.5 2.67 2 1.2	30 *40 *35 *26 *30	100 200 50 0.3 50	1 15 .05 10 10	*200 1.2 0.7	18 5 - 1 40	Industrial Type TI RO97A package, CDC
N 23	2N215 2N3709 MPS3709 2N3708 MPS3708	RCA TI MO TI MO	pnp,AJ,ge npn,PE,si npn,EP,si npn,PE,si npn,EP,si	*45-165 *45-165 *45-660 *45-660	150 250 310 250 310	70 125 135 125 125 135	2.5 2.81 2.5 2.81	*30 30 30 30 30	50 30 30 30 30 30	10 0.1 0.1 0.1 0.1	0.7 - - - -	1 † 92 † 92	†Plastic †Plastic
A 24	2N280 OC71N 2N119 2N335 2N1152	AMP AMP TI TI	pnp,AJ,ge pnp,AJ,ge npn,si npn,si npn,si	47 47 49 49 49	125 110 150 150 150	75 75 175 175 175	2.5 0.45 1.19 1	30 30 *45 *45 *45	10 10 25 25 25 25	150 - 1 2 2	0.1 - - - -	1 - 5 -	Special Case TR GE, TR TR
A 24	2N917 2N918 2N1443 2N2616 2N2729	FA FA NA FA FA	npn,DP,si npn,PE,si pnp,A,si npn,PE,si npn,PE,si	50 *50 50 *50 *50	300 300 400 800 800	200 200 200 200 200 200	1.71 1.71 2.25 4.56 4.56	15 15 15 15 15	50 100 50 50	0.0005 0.002 .025 0.002 0.002	*800 *900 - *900 900	18 18 5 18 18	TI, RCA, AL, TRWS MO, TI, RCA, AL, TRWS CT AL AL
A 25	2N3581 A569 A570 A1341 BC410	SSD AMP AMP AL AMP	pnp,EP npn,PL,si npn,PL,si npn,si pnp,AJ,si	*50 *50 *50 *50 50	400 300 300 200 310	200 175 175 150 150	2.28 2 2 - 2.5	40 *20 *20 *75 32	30 - - - 500	0.02 .01 0.1 .010 0.1	30 100 100 - 1.5	46 18 18 18 18	Chopper, ▲Voff,=50µV Chopper, Voff,=100µV
A 23	ME216 NS-661 NS-665 2N214 2N1059	AMP NA NA SY SY	npn,PL,si pnp,A,si pnp,A,si npn,AL,ge npn,AL,ge	50 50 50 *50-100 *50-100	360 400 150 180 180	200 175 175 85 85	2 2.5 1 -	*20 30 30 *40 *20	100 100 100 100 100	.5 1 1 50 20	100 - - .01 .10	18 5 18 22 22	Industrial Type Industrial Type
A 26	2N651 2N651A 2N1187 MA882 MA887	MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	50-120 50-120 50-120 50-120 50-120	200 200 200 200 200 200	100 100 100 100 100	2.67 2.67 2.67 2.67 2.67 2.67	*45 *45 *60 *60 *50	500 500 500 500 500	10 10 10 10 10	- 2 †1.0 †1.0	5 5 5 5 5	TI TI †fab †fab
A 26	2N654 2N2706 PA1001 40232 BC 122	MO MO AL RCA SA	pnp,AJ,ge pnp,AJ,ge npn,DP,si npn,P,si npn,PE,si	50-125 50-150 *50-150 50-180 50-400	200 200 - 500 75	100 100 200 175 125	2.67 2.66 2 .33 5.0	*30 *25 *60 18 20	250 400 - 100 50	15 10 .010 0.25 0.01	+3 - *60 250	5 5 18 - -	†fab
A 27	2N565 2N566 2N2717 OC58 2N3394	GI GE AMP GE	pnp,AJ,ge pnp,AJ,ge npn,PL,si pnp,AJ,ge npn,PL,si	55 55 55 55 *55-110	150 120 200 20 20 200	85 85 100 75 100	2.5 2.0 2.67 1.5 2.67	*30 *30 - 7 25	300 300 100 5 100	5 5 0.5 1.5 0.1	1 1 - 1.6 -	- 5 18 - 98	IND Sub min case Epoxy case
K 21	MPS3394 MPS3397 MPS3398 2N169 2N449	MO MO MO GE GE	npn,EP,si npn,EP,si npn,EP,si npn,GR,ge npn,GR,ge	*55-110 *55-500 *55-800 *60 *60	310 310 310 65 65	135 135 135 85 85	2.81 2.81 2.81 1.1 1.1	25 25 25 15 15	100 100 100 20 20	0.1 0.1 0.1 - -	- - 8 8	92 92 92 -	
A 28	2N736A 2N929 2N957 2N1097 2N1098	TI TI FA GE GE	npn,si npn,si npn,DD,si pnp,AJ,ge pnp,AJ,ge	60 60 *60 *60 *60	500 300 800 175 175	175 175 150 - -	3.33 2 6.5 2.9 2.9	60 45 20 *16 *16	100 30 - 200 200	0.5 0.01 1.0 16 16	- 250 - -	18 18 18 5 5	TR FA, GI, TR, AL, SPR, UC, MO TRWS, AMP
A 20	2N1121 2N1376 2N1377 2N1414 2N1566A	GE TI TI GE TI	npn,GR,ge pnp,ge pnp,ge pnp,AJ,ge npn,si	*60 60 60 *60 60	65 250 250 200 600	85 100 100 85 175	1.1 3.3 3.3 3.33 4	15 *25 *45 *35 60	20 200 200 200 200 100	7 7 7 12 0.1	8 - - - -	5 5 5 5	

						MAX.	RATINGS			CHARACT	ERISTICS		
Cross Index Key	Type No.	Mfr.	Туре	h _{fe} *h _{FE}	P _c (mW)	T _j (°C)	mW/°C	*VCEO	I _c (mA)	Ι co (μ A)	f αe *f _T (MHz)	Package Outline (TO-)	Remarks
A 29	2N2387 2N2600A BCZ10 BCZ11 OC60	TI SSD AMP AMP AMP	npn,si pnp,EP pnp,AJ,si pnp,AJ,si pnp,AJ,ge	60 *60 60 60	300 400 250 250 20	175 200 150 150 75	2 2.28 2 2 1.5	45 100 25' 25 7	30 30 50 50 50	0.01 0.025 0.1 0.1 1.5	- 80 1 3 1.6	50 46 1 1	Sub min case
N 23	S15660 SFT323 SFT353 2N3858 2N3858A	FA NUC NUC GE GE	npn,DPE,si pnp,ge pnp,ge npn,PEP,si npn,PEP,si	*60 *60 60 *60-120 *60-120	600 200 200 200 200 200	200 85 85 100 100	3.42 - 2.67 2.67	*40 *24 *24 30 60	1000 250 150 100 100	- 15 15 0.5 0.1	650 - - - -	- 1 1 98 98	RO83 package
4.00	2N660 2N3721 MPS3721 2N2430 2N175	TI GE MO AMP RCA	pnp,AJ,ge .npn,PL,si npn,EP,si npn,ge pnp,AJ,ge	*60 - 150 60 - 660 60 - 660 *63 65	250 200 310 360 20	100 100 135 90 71	6.66 2.67 2.81 3.3	12 18 18 *32 *10	1000 100 100 30 2	6 0.5 0.5 - 12	- - - - .85	5 98 92 1 40	
A 30	2N220 2N407 2N408 2N649 2N1924	RCA RCA RCA RCA GE	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,ge	65 *65 *65 *65 *65	20 150 150 100 225	71 71 71 71 71 85	- - - - 3.7	*10 *20 *20 25 *60	2 70 70 50 50	12 14 14 14 10	0.85 - - - -	1 40 1 1 5	LAN LAN
	2N3062 2N3063 BCY40 2N270 2N281	CT CT AMP RCA AMP	pnp,si pnp,si pnp,AJ,si pnp,AJ,ge pnp,AJ,ge	65 65 *68 *70 70	400 400 120 250 165	200 200 150 50 75	2.3 2.3 2 - .3	*90 *90 *32 *25 *32	100 100 250 75 50	.01 .01 .1 10 4.5	- .85 1 0.9	46 46 5 7 1	
A 31	2N282 2N591 2N647 2N1592 2N1593	AMP RCA RCA TI TI	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge npn,si npn,si	70 70 *70 70 70	165 50 100 125 125	75 71 71 87.5 87.5	.3 - - 2 2	*32 32 25 10 20	50 20 50 25 25	4.5 7 14 1	0.9 0.7 - -	1 1 1 -	Matched Pair 2N281's LAN TR TR
	2N1594 2N3128 A1109 2N1175A 2N1705	TI NA AL MO MO	npn,si npn,PL,si npn,si pnp,AJ,ge pnp,AJ,ge	70 70 *70 *70-140 70-150	125 150 - 200 200	87.5 150 150 100 100	2 1.2 - 3.33 2.66	40 20 *45 *35 *18	25 100 - 200 400	1 .002 .10 12 10	- - - +3	- - 18 5 5	TR †fab
A 32	2N213 2N1251 2N109 2N217 2N412	SY SY RCA RCA RCA	npn,AL,ge npn,AL,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	70-250 *70-250 *75 *75 75	180 180 150 150 80	85 85 71 71 71	11111	*40 *20 *25 *25 13	100 100 70 70 15	50 20 7 7 10	0.1 7.5 1 1 10	22 22 40 1	LAN LAN LAN
	2N1378 2N1379 40253 0C74 2N1431	TI TI RCA AMP SY	pnp,ge pnp,ge pnp,AJ,ge pnp,AJ,ge npn,AL,ge	75 75 *75 75 75 *75-150	250 250 650 0.55 180	100 100 90 75 85	3.3 3.3 10 .66	*12 *25 *25 *25 20 *25	200 200 500 300 100	7 7 14 (max) 10 20	- *1 1.5 .01	5 5 1 1 22	
A 33	2N1189 2N2712 2N2714 2N3402 2N3404	MO GE GE GE GE	pnp,AJ,ge npn,PL,si npn,PEP,si npn,PE,si npn,PE,si	*75-175 *75-225 *75-225 *75-225 *75-225	200 200 200 560 560	100 100 100 150 150	2.67 2.67 2.67 4.47 4.47	*45 18 18 25 50	500 100 200 500 500	10 0.5 0.5 0.1 0.1	11111	5 98 98 98 98	NUC Epoxy case, heat clip Epoxy case, heat clip
	2N3414 2N3416 MPS2712 MPS2716 2N336A	GE GE MO MO GE	npn,PE,si npn,PE,si npn,EP,si npn,EP,si npn,DG,si	*75-225 *75-225 *75-225 *75-225 76-333	360 360 310 310 500	150 150 135 135 175	2.67 2.67 2.81 2.81 3.33	25 50 18 18 45	500 500 100 25 25	0.1 0.1 0.5 0.5 .5	11111	98 98 92 92 5	Epoxy case Epoxy case TR
A 34	2N760 2N760A 2N2676 2N661 2N736	NA NA GE TI	npn,DM,si npn,DM,si npn,DG,si pnp,AJ,ge npn,si	76-333 76-333 76-333 *80 80	500 500 250 250 500	200 200 175 100 175	2.5 2.5 1.66 6.66 3.33	45 60 *60 12 60	100 100 25 100 50	0.2 0.1 .1 6	11111	18 18 46 5 18	TR, GI, AL TR, GI, AL TRWS, TR
	2N740 2N1415 2N1566 2N1574 2N3462	TI GE TI TI AMP	npn,si pnp,AJ,ge npn,si npn,si npn,si	80 *80 80 80 *80	500 200 600 600 600	175 85 175 175 200	3.33 3.33 4 4 1.7	80 *35 60 80 35	50 200 50 50 50	1 12 1 1 0.07	11111	18 5 5 5 18	TR, AL TRWS, TR TR Low Noise
A 35	2N3463 40261 OC59 2N543A 2N2245	AMP RCA AMP TR NA	npn,si pnp,DR,ge pnp,AJ,ge npn,PL,si npn,DM,si	*80 80 80 80-200 80-250	300 80 20 200 500	200 85 75 175 200	1.7 1.2 1.5 1.2 2.5	50 *50 7 50 20	50 10 5 25 100	0.002 12 (max) 1.5 .5	- *40 2.2 10 -	18 1 - 5 18	Low Noise Sub min case Low Level

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						MAX.	RATINGS			CHARACT	ERISTICS		
Cross Index Key	Type No.	Mfr.	Туре	h _{fe} *h _{FE}	P _c (mW)	T _j (°C)	mW/°C	V CEO *V CBO (V)	I _c (mA)	Ι (μ A)	fae *fT (MHz)	Package Outline (TO-)	Remarks
	2N2248 2N2251 2N2254 2N2715 2N3060	NA NA NA GE CT	npn,DM,si npn,DM,si npn,DM,si npn,PL,si pnp,si	80-250 80-250 80-250 82 85	500 500 500 200 400	200 200 200 100 200	2.5 2.5 2.5 2.67 2.3	45 20 45 *18-18 *70	100 100 100 100 100	.01 .01 .01 0.5 .005		18 18 18 18 46	Low Level Low Noise, CDC Low Noise IEC, GME
A 36	2N1144 2N1145 2N1925 2N2431 2N3058	GE GE GE AMP CT	pnp,AJ,ge pnp,AJ,ge pnp,ge pnp,ge pnp,si	*90 *90 *90 *90 90	175 175 225 1000 400	85 85 85 75 200	2.9 2.9 3.7 3.3 2.3	*16 *16 *60 *32 6	200 200 500 1000 100	16 16 10 10 .0001	1.7	- 5 1 46	
	OC75N 2N2923 2N3393 MPS3393 40231	AMP GE GE MO RCA	pnp,AJ,ge npn,PL,si npn,PL,si npn,EP,si npn,P,si	90 90-180 *90-180 *90-180 90-300	110 200 200 310 500	75 100 100 135 175	0.45 2.67 2.67 2.81 .33	30 25 25 25 25 18	10 100 100 100 100	- 0.5 0.1 0.1 0.5	- - - *60	1 98 98 92 -	IEC, GME Epoxy case, GME
A 37	40233 2N3710 MPS3710 MPS3396 2N120	RCA TI MO MO TI	npn, f,si npn,PE,si npn,EP,si npn,EP,si npn,si	90-300 *90-330 *90-330 *90-500 99	500 250 310 310 150	175 125 135 135 175	.33 2.5 2.81 2.81	18 30 30 25 *45	100 30 30 100 25	0.5 0.1 0.1 0.1 2	*60 - - - -	- † 92 92 -	†Plastic
	2N336 2N1153 2N567 2N568 2N3130	TI TI GI GI NA	npn,si npn,si pnp,AJ,ge pnp,AJ,ge npn,PL,si	99 99 100 100 100	150 150 150 120 150	175 175 85 85 150	1 1 2.5 2.0 1.2	*45 *45 *30 *30 60	25 25 300 300 100	2 2 5.0 5.0 .002	- 1.5 1.5 -	5 - - 5 -	GE, TR TR IND
A 38	2N3582 A307 ME213 ME217 ME900A	SSD AMP AMP AMP AMP	pnp,EP npn,PL,si npn,PL,si npn,PL,si npn,PL,si	*100 100 100 100 100	400 360 360 360 360	200 200 200 200 200 200	2.28 2 2 2 2 2	40 *25 *45 *20 *40	30 - - - -	0.02 .01 .1 .5 .01	30 100 100 100 100	46 18 18 18 18	
	ME901 ME901A 2N508A 2N3859 2N3859A	AMP AMP MO GE GE	npn,PL,si npn,PL,si pnp,AJ,ge npn,PEP,si npn,PEP,si	100 100 *100-200 *100-200 100-200	360 360 200 200 200 200	200 200 100 100 100	2 2 3.33 2.67 2.67	*40 *40 *30 30 60	- 200 100 100	.01 .01 7 0.5 0.1	100 100 	18 18 5 98 98	
A 39	2N652 2N652A 2N1188 MA883 MA888	MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	100-225 100-225 100-225 100-225 100-225	200 200 200 200 200 200	100 100 100 100 100	2.67 2.67 2.67 2.67 2.67	*45 *45 *60 *60 *50	500 500 500 500 500 500	10 10 10 10 10	- - 1.25 †1.25	5 5 5 5	TI TI †fab †fab
	2N213A 2N655 2N1193 2N4032 2N4033	SY MO MO FA FA	npn,AL,ge pnp,AJ,ge pnp,AJ,ge pnp,PE,si pnp,PE,si	100-250 100-250 100-250 100-300 100-300	180 200 200 800 800	85 100 100 200 200	2.67 2.67 22.8 22.8	*40 *30 *40 60 80	100 250 200 -	50 15 15 .2 .2	0.1 - - 100 150	22 5 5 - -	TI TI
A 40	PA1000 2N3692 2N3707 MPS3707 2N2716	AL FA TI MO GE	npn,DP,si npn,PL,si npn,PE,si npn,EP,si npn,PL,si	*100 - 300 *100 - 400 *100-400 *100-400 110	- 625 250 310 200	200 150 125 135 100	2 2 2.5 2.81 2.67	*30 *35 30 30 -	50 30 30 100	.010 .05 0.1 0.1 0.5	*200 - - -	18 - † 92 18	RO97A package, CDC †Plastic NUC, IEC, GME
	40329 2N2171 2N1926 2N1190 BC 107	RCA MO GE MO SA	pnp,AJ,ge pnp,AJ,ge pnp,ge pnp,AJ,ge npn,PE,si	120 120-310 *121 *125-300 *125-500	125 500 85 200 260	100 100 3.7 100 175	2.8 6.7 *60 2.67 5.0	*25 *50 500 *45 45	100 400 10 500 100	14 (max) 10 - 10 0.0007	1.5 +7.5 - 150	1 5 5 5 18	†fab
A 41	2N2903 2N2903A 2N2428 AC 163 2N2706	AL AL AMP SA AMP	npn,DP,si npn,DP,si pnp,ge pnp,AJ,ge pnp,AJ,ge	*125 - 625 *125 - 625 130 *130 *130	600 600 500 900 500	200 200 75 90 90	3.5 3.5 0.3 20 0.37	*60 *60 32 24 *32	- 100 200 200	.010 .010 	- 1.7 2.3 2.5	5 5 1 1 1	Dual Dual
	2N2707 AF 127 2N569 2N570 2N930	AMP SA GI GI TI	ge pnp,AD,ge pnp,AJ,ge pnp,AJ,ge npn,si	*135 140 150 150 150	500 60 150 120 300	90 75 85 85 175	0.37 2.5 2.5 2.0 2	*32 32 *30 *30 45	200 10 300 300 300 30	1.2 5 5 0.01	2.5 75 2 2	1 18 - 5 18	Matched NPN, PNP Pair IND FA, GI, TR, NUC, SPR, UC, MO
A 42	2N2388 2N2586 2N3129 40262 AC172	TI TI NA RCA AMP	npn,si npn,si npn,PL,si pnp,DR,ge npn,AJ,ge	150 150 150 150 150	300 300 150 80 280	175 175 150 85 75	2 2 1.2 1.2 2.7	45 45 45 *50 32	30 30 100 10 200	0.01 0.002 .002 12 (max)	- - *30	50 18 - 1 1	AMP, FA, AL, UC

After 130,000,000 diodes

1-amp glass rectifiers come easy

The basic technology required for making silicon glass rectifiers has long since been proved out in ITT's diode operation. More than 130,000,000 diodes last year paved the way for 1966 1-amp glass rectifier capability that's already operating at better than a 1.2 million annual rate.

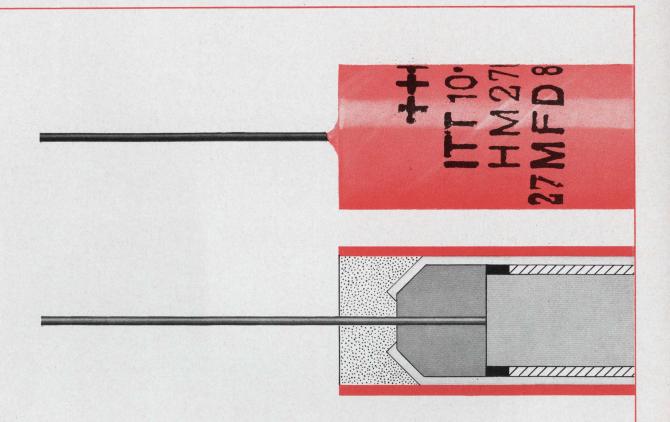
If you're using old-fashioned top-hats because delivery is slow on DO-29 glass rectifiers, make the switch now.

ITT offers immediate shipment of 200 to 1000 V, 1-amp glass rectifiers from factory stock or from ITT distributors' shelves. See how fast silicon glass rectifier delivery can be — call your ITT factory representative or any of ITT's semiconductor distributors throughout the United States today. ITT Semiconductors, a division of International Telephone and Telegraph Corporation, 3301 Electronics Way, West Palm Beach, Florida.



FACTORIES IN PALO ALTO, CALIFORNIA; LAWRENCE, MASSACHUSETTS; WEST PALM BEACH, FLORIDA; HARLOW-AND FOOTSCRAY, ENGLAND, FREIBURG AND NURENBERG, GERMANY

						MAX.	RATINGS			CHARAC	TERISTICS		
Cross Index Key	Type No.	Mfr.	Туре	h _{fe} *h _{FE}	P _c (mW)	T _j (°C)	mW/°C	*VCEO *VCBO (V)	I _c (mA)	ι _{со} (μ A)	f ae *f _T (MHz)	Package Outline (TO-)	Remarks
A 40	2N2924 2N3392 2N3860 2N4086 MPS3392	GE GE GE MO	npn,PL,si npn,PL,si npn,PEP,si npn,PL,si npn,EP,si	150-300 *150-300 *150-300 *150-300 *150-300	200 200 200 200 200 310	100 100 100 100 100 135	2.67 2.67 2.67 2.67 2.81	25 25 30 12 25	100 100 100 100 100	0.5 0.1 0.5 0.1 0.1	11111	98 98 98 98 98	IEC, GME Epoxy case, GME
A 43	2N2246 2N2249 2N2252 2N2255 MPS3395	NA NA NA NA MO	npn,DM,si npn,DM,si npn,DM,si npn,DM,si npn,EP,si	150-450 150-450 150-450 150-450 *150-500	500 500 500 500 500 310	200 200 200 200 200 135	2.5 2.5 2.5 2.5 2.81	20 45 20 45 25	100 100 100 100 100	.01 .01 .01 .01 .01		18 18 18 18 92	Low Level Low Level Low Noise, CDC, AMP Low Noise
A 44	2N2453 2N2453A 2N3061 2N2613 2N3241	AL AL CT RCA RCA	npn,DP,si npn,DP,si pnp,si pnp,AJ,ge npn,PL,si	*150 -600 *150 -600 155 160 175	600 600 400 120 500	200 200 200 200 100 175	114 1.14 2.3 -	*60 *80 *70 *30 25	9 9 100 50 100	.005 .005 .005 5	- - 10 60	5 5 46 1	Dual Dual †fT
A 44	2N3242 2N3403 2N3405 2N3415 2N3417	RCA GE GE GE GE	npn,PL,si npn,PE,si npn,PE,si npn,PE,si npn,PE,si	175 *180-540 *180-540 *180-540 *180-540	500 560 560 360 360	175 150 150 150 150	4.47 4.47 2.67 2.67	25 25 50 25 50	200 500 500 500 500 500	0.01 0.1 0.1 0.1 0.1	60 - - - -	98 98 98 98	†fT Epoxy case, heat clip Epoxy case, heat clip Epoxy case Epoxy case, heat clip
	2N3711 MPS3711 2N1185 MA884 MA889	TI MO MO MO MO	npn,PE,si npn,EP,si pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	*180-660 *180-660 190-400 190-400 190-400	250 310 200 200 200 200	125 135 100 100 100	2.5 2.81 2.67 2.67 2.67	30 30 *45 *60 *50	30 30 500 500 500	0.1 0.1 10 10 15	- - - †1.75 †1.75	† 92 5 5 5	†Plastic †fab †fab
A 45	2N1194 2N1086 2N1086A 2N1087 2N571	MO GE GE GE GI	pnp,AJ,ge npn,GR,ge npn,GR,ge npn,GR,ge pnp,AJ,ge	190-500 195 195 195 200	200 65 65 65 150	100 85 85 85 85	2.67 1.1 1.1 1.1 2.5	*40 9 9 9 *30	200 20 20 20 20 300	15 - - - 5	- 8 8 8 8	5 - - -	П
	2N572 2N2614 2N3059 2N3427 MA1703	GI RCA CT MO MO	pnp,AJ,ge pnp,AJ,ge pnp,si pnp,AJ,ge pnp,AJ,ge	200 200 200 200 200-500 200-500	120 120 400 200 200	85 100 200 100 100	2.0 - 2.3 2.67 2.67	*30 *40 6 *45 *25	300 50 100 500 500	5 5 .0001 3.0 3.0	3 10 - 6.0 †3.0	5 1 46 5 5	IND †fab
A 46	MA1706 2N2429 2N2925 D16E7 D16E9	MO AMP GE GE GE	pnp,AJ,ge pnp,ge npn,PL,si npn,PEP,si npn,PEP,si	200-500 220 235-470 *235-470 *235-470	200 500 200 200 200 200	100 75 100 100 100	2.67 3.3 2.67 2.67 2.67	*15 32 25 18 25	500 100 100 100 100	15 - 0.5 0.5 0.5	†3.0 2.3 - -	5 1 98 98 98	†fab IEC, GME
	ME495 2N3900A 2N3391 2N3391A 2N3900	AMP GE GE GE GE	npn,PL,si npn,PL,si npn,PL,si npn,PL,si npn,PL,si	*250 250-500 *250-500 *250-500 *250-500	360 200 200 200 200 200	200 100 100 100 100	2 2.67 2.67 2.67 2.67	*40 18 25 25 18	- 100 100 100 100	1 0.1 0.1 0.1 0.1		18 98 98 98 98	5 dB(max nf) Economy – Epoxy, NUC, IEC, GME 5 dB(max nf), GME
A 47	2N4087 2N4087A ME213A 2N2953 2N4017	GE GE AMP RCA FA	npn,PL,si npn,PL,si npn,PL,si pnp,AJ,ge pnp,DPE,si	250-500 250-500 300 350 *350	200 200 360 120 600	100 100 200 100 200	2.67 2.67 2 - 3.4	12 12 45 *30 *80	100 100 - 150 200	0.1 0.1 .1 5 10	- 100 10 5.5	98 98 18 1	5 dB(max nf) RO52A package, Dual pnp
	2N3428 MA1704 MA1707 2N3078 2N3390	MO MO MO AMP GE	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge npn,PL,si npn,PL,si	350-800 350-800 350-800 360 *400-800	200 200 200 200 360 200	100 100 100 200 100	2.67 2.67 2.67 2.06 2.67	*45 *25 *15 *80 25	500 500 500 500 100	3.0 3.0 15 .01 0.1	8.0 †5.0 †4.0 –	5 5 5 18 98	†fab †fab TR Economy — Epoxy, NUC, IEC, GME
A 48	2N4018 2N4019 MA1702 MA1705 MA1708	FA FA MO MO MO	pnp,DPE,si pnp,DPE,si pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	*500 *500 500 500 500	600 600 200 200 200 200	200 200 100 100 100	3.4 3.4 2.67 2.67 2.67	*60 *45 *45 *25 *15	200 200 500 500 500	10 10 3.0 3.0 3.0 15	7.0 7.0 †7.0 †6.0 †5.0	- 5 5 5	RO52A package, Dual pnp RO52A package, Dual pnp †fab †fab †fab
	2N3077 A520/A521 S15650 2N3395 2N3396	ÁMP AMP FA GE GE	npn,PL,si npn,PL,si npn,DPE,si npn,PL,si npn,PL,si	600 600 *600 800 800	360 300 200 -200 200	200 200 125 125 125	2.06 1.72 5 0.375 9.375	*80 80 25 25 25 25	50 50 - 100 100	.01 .005 .050 0.1	- 60 40 -	18 5 - †	TR 6 lead diff amp RO110 package Economy — Epoxy, GME, IEC Economy — Epoxy, GME, IEC
A 49	2N3397 2N3398 2N2785 2N997 2N35	GE GE GE TI	npn,PL,si npn,PL,si npn,PL,si npn,si pnp,AS,ge	800 1250 2000 *7000	200 200 1800 500 50	125 125 200 175	0.375 0.375 10 3.33	25 25 40 40 *25	100 100 500 300	0.1 0.1 10 0.01	1111	† † 5 18 –	Economy — Epoxy, GME, IEC Economy — Epoxy, GME, IEC SPR (Darlington),FA, SPR SY, GI



Why ITT wet tantalum capacitors can't leak

Every ITT Red Cap® wet tantalum capacitor gets a "total stress" seal that, unlike the ordinary single-crimp seal, positively prevents electrolyte leakage. To accomplish this, ITT inserts a teflon end seal, then spins down the open end of the can until end seal, anode and insulating washer are under a predetermined compressive force.

Seal integrity is further insured by the addition of an epoxy end fill. Since the epoxy's expansion coefficient is less than that of the can, temperature cycling cannot relax the spun seal.

If you're tired of electrolyte leaks and the problems that go with them, here's an easy solution. Order the ones that can't leak — the Red Caps® — from your ITT Capacitor distributor or from ITT Semiconductors, a division of International Telephone and Telegraph Corporation, 3301 Electronics Way, West Palm Beach, Florida.



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						MAX.	RATINGS			CHARAC	TERISTICS		
Cross Index Key	Type No.	Mfr.	Туре	h _{fe} *h _{FE}	P _c (mW)	T _j (°C)	mW/°C	V CEO *V CBO (V)	I _c (mA)	ι (μ A)	fae *fT (MHz)	Package Outline (TO-)	Remarks
A 50	2N331 2N1392 2N1393 2N4020 2N4021 2N4021 2N4022 2N4023 2N4024 2N4025 FT4020	GI GI FA FA FA FA FA	pnp,AJ,ge pnp,ge pnp,ge pnp,DPE,si pnp,DPE,si pnp,DPE,si pnp,DPE,si pnp,DPE,si pnp,DPE,si pnp,DPE,si pnp,DPE,si	-	200 50 50 600 600 600 600 600 600 500	71 - 200 200 200 200 200 200 200 200 200	- 0.8 0.8 2.3 2.3 2.3 2.3 2.3 2.3 2.3 2.3	*30 *20 *20 *45 *45 *45 45 45 45	- - 200 200 200 200 200 200 200 200	16 8.0 8.0 10 10 10 10 10 10 10	160 160 160 160 160 160 160 0.7	5	MO, GI, IND RO52A package, Dual pnp Dual pnp Dual pnp
A 51	FT4021 FT4022 FT4023 FT4024 FT4025 ME209 ME214 SP10801 SP10810 SP10811	FA FA FA FA AMP AMP FA FA	pnp, DPE, si pnp, DPE, si pnp, DPE, si pnp, DPE, si pnp, DPE, si npn, PE, si npn, PE, si npn, DP, si pnp, DPE, si pnp, DPE, si pnp, DPE, si	1111111111	500 500 500 500 500 300 300 350 350 350	200 200 200 200 200 200 175 175 200 200	2.8 2.8 2.8 2.8 2.8 2.2 2 2	60 60 45 60 60 *10 *45 *45 *20 *20	200 200 200 200 200 	10 10 10 10 10 10 .002 .002	0.55 0.7 0.7 0.55 0.7	- - - - 18 18 89 89	Dual pnp Dual pnp Dual pnp Dual pnp Dual pnp Dual pnp Chopper, Voff=250nV Chopper, Voff=500nV

(see pages 4-9 for explanation of company abbreviations.)

Late-arrivals . . .

The following bipolar transistor families, manufactured by General Instrument, are epoxy encapsulated units (TO-18 cans) similar or equivalent in characteristics to their metal-can counterparts (for detailed information on device properties use the literature offering form and reader-service card, p. 4):

Audio and general purpose

2N2711 · 2N2716 2N3390 · 2N3398 2N2721 · 2N2726 2N3414 · 2N3416

High-frequency

 2N3563 · 2N3566
 2N3702 · 2N3711

 2N3605 · 2N3607
 2N3900 · 2N3905

 2N3638 · 2N3645
 2N3983 · 2N3985

High-level switching

2N4140 - 2N4143 (similar to 2N2221, 2N2222, 2N2906, 2N2907)

2N4227 - 2N4228 (direct equivalents of metal-can types)



NEW contactless meter relays (41/2")

Utter reliability...utter simplicity. Completely fail-safe circuitry insures 100% reliability. No limitation on pointer travel due to mechanical contacts. Model 3324XA meter relays are CONTACTLESS. An infinite life lamp and photo-conductors do the sensing. Solid state switching circuit and relay (10 amp, DPDT, 115 VAC) are contained internally on single control point units. Double control point models also available. Control point indication is within 2% of actual switching. Available THROUGH DISTRIBUTORS in ranges shown.

RANGE	Approx.	Single	Control	Double (Control
RANGE	Ohms	Cat. No.	Price	Cat. No.	Price
DC Microamm	eters			THE PARTY OF	- 300
0-50	3000	16451	\$99.00	16470	\$136.35
0-100	1300	16452	96.15	16471	133.65
0-200	570	16453	96.15	16472	133.50
0-500	220	16454	96.15	16473	133.50
DC Milliamme	ter		1000		
0-1	80	16455	95.10	16474	132.45
DC Millivoltme	eter			The same of	7 8 7 5 5
0-50	10	16460	63.60	16480	137.25

NEW miniature edgewise meters (1½")

Takes only half the space of a $2\frac{1}{2}$ " Edgewise meter with little sacrifice in scale length. Movement is self-shielded. DC accuracy is $\pm 2\%$ (F.S.); AC (rectifier type), $\pm 3\%$ (F.S.) at 25°, 60 cycle sine wave. Dustproof case. Meter comes complete with bezel and mounting hardware. 20 Ranges are STOCKED (see sampling below). Contact your ELECTRONIC DISTRIBUTOR about Model 1521.

RANGE	Approx. Ohms	Cat. No.	Price
DC Voltometers 0-150	1000 o/v	10358	\$15.45
DC Milliammeters 0-100	1.35	6817	15.90
DC Millivoltmeters 0-50	10	0713	16.20
DC Microammeters 0- 2 5	3150	4552	23.40
AC Voltmeters 0-150	1000 o/v	10415	20.10

For Complete Details, Request Bulletin 2073 and Meter Relay Reprint Article.

SIMPSON ELECTRIC COMPANY

5202 W. Kinzie Street, Chicago, III. 60644 • Phone: 312-379-1121

Export Dept.: 400 W. Madison Street, Chicago, III. 60606 • Cable, Amergaco

In Canada: Bach-Simpson Ltd., London, Ontario

In India: Ruttonsha-Simpson Private Ltd., International House, Bombay-Agra Road, Vikhroli, Bombay



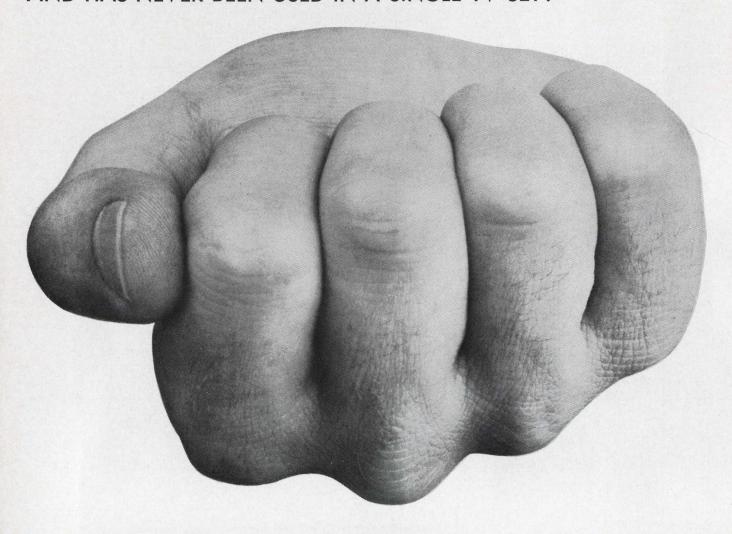
High-Frequency

Includes types ranging up to and above the vhf range. Listed in order of increasing $f_{\alpha e}$ or $f_{\rm T}$.

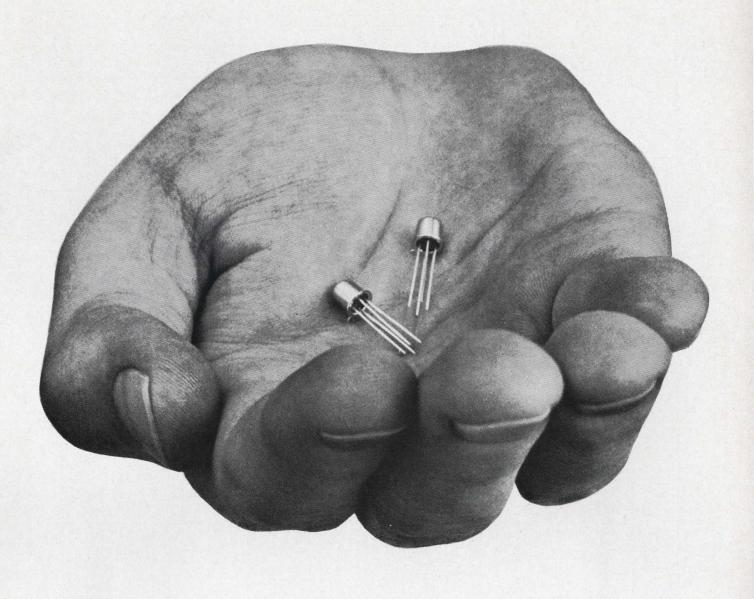
					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Туре	fae *f _T (MHz)	P c (m W)	T _j (°C)	mW/°C	*VCEO *VCBO (V)	1 _C (mA)	h _{fe}	*ICEO	Coe *Cob (pF)	Package Outline (TO-)	Remarks
HF1	2N2709 2N444 2N444A 2N3296 2N3297	RA GI GI MO MO	pnp,si npn,AJ,ge npn,AJ,ge npn,E,si npn,E,si	0.05 1 1 *1 *1	250 100 150 6W 25W	160 85 100 175 175	1.85 1.67 2 40 167	35 *15 *35 *60 *60	50 - - 700 1.5a	*10 10 15 *5-50 *2.5-35	1 6 4 0.1 1.0	*110 *16 *14 *20 *60	5 5 5 - 3	TI, ETC TI, ETC Special ceramic stud-mount
HF 2	2N94 2N233 2N233A 2N445 2N445A	SY SY SY GI GI	npn,AL,ge npn,AL,ge npn,AL,ge npn,AJ,ge npn,AJ,ge	2 2 2 2 2.	150 150 150 100 150	100 85 85 85 100	- - 1.67 2.0	*20 *10 *10 *15 *25	100 100 100 -	*10-80 10 *10 20 35	30 - - 6 4	9 7 7 *16 *14	22 22 22 5 5	ETC ETC ETC TI, ETC TI
	2N515 2N516 2N3295 2N1391 2N2946	SY SY MO GI CT	npn,AL,ge npn,AL,ge npn,E,si hpn,AJ,ge pnp,PE,si	2 2 2 3 *3	150 150 2W 150 400	85 85 175 100 200	- 13.3 2. 2.4	*18 *18 *60 *25 *40	100 100 250 - 100	*10-50 *15-75 *20-60 *40-160 *30-150	50 50 0.1 4 0.0005	8 8 *8 *20 *10	22 22 5 5 46	SPR
HF 3	SFT337 2N212 2N517 2N1058 2N139	NUC SY SY SY RCA	pnp,ge npn,AL,ge npn,AL,ge npn,AL,ge pnp,AJ,ge	3 4 4 4 4.7	150 150 150 50 80	80 85 85 75 70	1-1-1	*15 *18 *18 *18 *16	100 100 100 50 15	60 *10-30 *20-100 *10-23 48	2.5 30 50 50 6	7 8 7	1 22 22 22 22 40	
	2N218 2N94A 2N211 2N446 2N446A	RCA SY SY GI GI	pnp, AJ, ge npn, AL, ge npn, AL, ge npn, AJ, ge npn, AJ, ge	4.7 5 5 5 5	80 150 150 100 150	70 100 85 85 100	- - 1.67 2	*16 *20 *18 *15 *25	15 100 100 - -	48 *7-21 *20-100 30 60	6 30 30 6.0 4.0	9 7 *16 *14	1 22 22 5 5	TI TI
35.4	2N1090 2N2945 FK3962 FV3962 2N2276	RCA SPR FA FA SPR	npn,AJ,ge pnp, PE, si pnp,DP,si pnp,DP,si pnp, AT, si	5 *5 5.5 5.5 *6	120 400 175 175 150	85 200 200 200 200 140	2.4 2 2 1.3	*25 *25 60 60 *15	400 100 50 50 50	*30 *40-250 *300 *300 *15	8 0.0002 - 0.003	*25 *10 *6 *6 *6.0	5 46 - 51 *18	GI Hermet package Matched Pair 2N227
HF 4	2N2277 3N90 3N91 3N92 3N93	SPR SPR SPR SPR SPR	pnp, SP,s i pnp,PE,si pnp,PE,si pnp,PE,si pnp,PE,si	*6 *6 *6 *6	150 300 300 300 300 300	140 200 200 200 200 200	1.3 1.7 1.7 1.7 1.7	*15 30 30 30 50	50 20 20 20 20 20	*15 - - - -	0.003 0.01 0.01 0.01 0.01	*6.0 8 8 8	18 18 18 18 18	Matched Pair 2N2276 Duet, Voff < 50μ V Duet, Voff < 100μ V Duet, Voff < 200μ V Duet, Voff < 50μ V
	3N94 3N95 3N112 3N113 2N409	SPR SPR SPR SPR RCA	pnp,PE,si pnp,PE,si pnp,PE,si pnp,PE,si pnp,AJ,ge	*6 *6 *6 *6 6.7	300 300 200 200 80	200 200 200 200 200 71	1.7 1.7 1.1 1.1	50 50 *50 *50 *13	20 20 20 20 20 15	- 1.5 1.5 48	0.01 0.01 .010 .010	8 8 *10 *10	18 18 90 90 40	Duet, Voff < 100μ V Duet, Voff < 200μ V Dual Dual
HF 5	2N410 FK3964 FV3964 SA-313 SA-314	RCA FA FA SPR SPR	pnp,AJ,ge pnp,DP,si pnp,DP,si pnp,SP,si pnp,SP,si	6.7 7 7 *7 *7	80 175 175 150 150	71 200 200 140 140	2 2 1.3 1.3	*13 45 45 20 15	15 50 50 50 50	48 *500 *500 *6 *8	10 - - 0.01 0.02	*6 *6 6	2 - 51 5 5	LAN Hermet package Symmetrical Symmetrical
	SA-316 SA-413 SA-414 SA416 2N2378	SPR SPR SPR SPR SPR	pnp,SP,si pnp,SP,si pnp,SP,si pnp,SP,si pnp,SAT,si	*7 *7 *7 *7 *7.2	150 150 150 150 150	140 140 140 140 140	1.3 1.3 1.3 1.3 1.3	10 20 15 10 *10	50 50 50 50 50	*10 *6 *8 *10 *25	0.003 0.01 0.02 0.003 0.001	6 6 6 *6	5 18 18 18 18	Symmetrical Symmetrical Symmetrical Symmetrical
HF6	2N3318 2N471A 2N472A 2N473 2N474	SPR TR TR TR TR	pnp,SPAT,si npn,PL,si npn,PL,si npn,PL,si npn,PL,si	*7.6 8 8 8	150 200 200 200 200 200	140 175 175 175 175 175	1.3 1.2 1.2 1.2 1.2	15 30 45 15 30	50 25 25 25 25 25	- 10-25 10-25 20-50 20-50	0.001 .5 .5 .5 .5	*9. *8 *8 *8 *8	18 5 5 5 5	Chopper
HF7	2N474A 2N475 2N475A 2N495 2N581	TR TR TR SPR RCA	npn,PL,si npn,PL,si npn,PL,si pnp,SPAT,si pnp,AJ,ge	8 8 8 *8	200 200 200 150 150	175 175 175 140 85	1.2 1.2 1.2 1.3	30 45 45 25 *18	25 25 25 50 100	20-50 20-50 20-50 15-30 30	.5 .5 .5 0.1 3	*8 *8 *8 *12	5 5 5 1 5	GI, TI , LAN, IND
	2N1054 2N1118 2N1118A 2N2377 SA-312	TR *SPR *SPR SPR SPR	npn,PL,si pnp,SAT,si pnp,SAT,si PNP,SAT,si pnp,SP,si	8 8 8 *8 *8	600 150 150 150 150	175 140 140 140 140	23 1.3 1.3 1.3 1.3	*125 25 25 *25 *25 10	750 50 50 50 50 50	*20 35 25 30 *10	5 0.001 0.001 0.002 0.01	*120 *6 *6 *6 *6	5 5 18 5	SSP *PH orig Reg, CT *PH orig Reg, CT Symmetrical

						M	X. RATI	NGS		CHARA	CTERISTI	CS		
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (MHz)	P c (m₩)	T _j (°C)	mW/°C	VCEO *VCBO (V)	1 (mA)	hfe *hFE	ICO *ICEO †ICEX (µA)	C _{oe} *C _{ob} (pF)	Package Outline (TO-)	Remarks
HF 8	SA-315 SA-412 SA-415 2N447 2N447A	SPR SPR SPR GI GI	pnp,SP,si pnp,SP,si pnp,SP,si npn,AJ,ge npn,AJ,ge	*8 *8 *8 9	150 150 150 100 15	140 140 140 85 100	1.3 1.3 1.3 1.67 2	12 10 12 *15 *25	50 50 50 - -	*10 *30 *10 50 85	0.01 0.01 0.01 6. 4	6 6 *16 *14	5 18 18 5 5	Symmetrical Symmetrical Symmetrical
III 6	2N447B 2N140 2N219 2N411 2N541	GI RCA RCA RCA TR	npn,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge npn,PL,si	9 10 10 10 10	150 80 80 80 200	100 70 70 71 175	2 - - 1.2	*25 *16 *16 *13	15 15 15 15 25	150 75 75 75 80-200	4 6 6 10 .5	*14 - - - *20	5 40 1 40 5	GE
HF 9	2N542 2N542A 2N543 2N602 2N1206	TR TR TR GI TR	npn,PL,si npn,PL,si npn,PL,si pnp,DR,ge npn,PL,si	10 10 10 *10 10	200 200 200 120 3000	175 175 175 175 85 175	1.2 1.2 1.2 2.0 25	30 30 50 *30 60	25 25 25 - 150	80-200 80-200 80-200 *20-80 *20-80	.5 .5 .5 8	*20 *8 *20 *7 50	5 5 5 5 5	GE GE GE
nry	2N1207 2N1907 2N1908 2N1974 2N2944	TR TI TI FA CT	npn,PL,si pnp,ge pnp,ge npn,DP,si pnp, PE, si	10 *10 *10 *10 *10	3000 60000 60,000 3w 400	175 100 100 200 200	25 2000 2000 17.2 2.4	125 *100 *130 60 *15	150 20 20 - 100	*20-80 *20 *20 *20 70 *80-450	1 500 500 0.005 0.0001	*50 - - *13 *10	5 3 3 5 46	TRWS, CDC, TR, AMP
	2N3317 2N3319 SA-310 SA-311 SA-410	SPR SPR SPR SPR SPR	pnp,SPAT,si pnp,SP,si pnp,SP,si pnp,SP,si pnp,SP,si	*10 *10 *10 *10 *10 *10	150 150 150 150 150	140 140 140 140 140	1.3 1.3 1.3 1.3 1.3	30 30 10 6	50 50 50 50 50	- *30 *15 *30	0.001 0.001 0.01 0.01 0.01	*9 *9 6 6 6	18 18' 5 5 18	Chopper Chopper Symmetrical Symmetrical Symmetrical
HF 10	SA-411 2N476 2N477 3N114 3N115	SPR TR TR SPR SPR	pnp,SP,si npn,PL,si npn,PL,si pnp,PE,si pnp,PE,si	*10 12 12 *12 *12 *12	150 200 200 300 300	140 175 175 200 200	1.3 1.2 1.2 1.7 1.7	10 15 30 *30 *30	50 25 25 20 20	*30 30-60 30-60 3	0.01 .5 .5 .010 .010	6 *10 *10 *10 *10	18 5 5 18 18	Symmetrical Dual Dual
	3N116 3N117 3N118 3N119 2N582	SPR SPR SPR SPR	pnp,PE,si pnp,PE,si pnp,PE,si pnp,PE,si pnp,AJ,ge	*12 *12 *12 *12 *12 18	300 300 300 300 300 150	200 200 200 200 200 85	1.7 1.7 1.7 1.7	*30 *50 *50 *50 *25	20 20 20 20 20 100	3 3 3 3 60	.010 .010 .010 .010 .010	*10 *10 *10 *10 -	18 18 18 18 5	Dual Dual Dual Dual GI, TI, RCA, LAN, IND
HF 11	2N1429 2N478 2N479 2N479A 2N480	TR TR TR TR	pnp,SAT,si npn,PL,si npn,PL,si npn,PL,si npn,PL,si	18 20 20 20 20 20	100 200 200 200 200 200	140 175 175 175 175	0.86 1.2 1.2 1.2 1.2	6 15 30 30 45	50 25 25 25 25 25	45 40-100 40-100 40-100 40-100	0.001 .5 .5 .5	*7 *8 *8 *8 *8	5 5 5 5	SPR, CT GE GE GE GE
	2N496 2N1065 2N2432 2N4138 S15649	*SPR GI TI TI FA	pnp,SPAT,si pnp,DR,ge npn,PE,si npn,PE,si npn,DP,si	*20 *20 *20 *20 *20 *20	150 120 300 300 200	140 85 175 175 125	1.3 2.0 2 2 5	10 *40 30 30 25	50 - 100 100	*25 *20-80 50 50 200-1000	0.1 8 0.01 0.01 3	*12 *7 *12 *12 4	1 5 18 46	*PH orig. Reg. R0110 package
HF 12	2N1411 OC45 2N274 2N344 2N345	SPR AMP RCA *SPR *SPR	pnp, MA, ge pnp, AJ, ge pnp, DR, ge pnp, SBT, ge pnp, SBT, ge	*25 *25 30 30 30	25 83 120 20 20	85 75 100 55 55	- 1.6 1.33 1.33	*5 *15 - *5 *5	50 5 -10 5 5	*75 75 60 22 35	0.3 0.5 4 0.7 0.7	*3 - *2 *3 *3	24 - 44 24 24	PH, GI Vcev=-40 *PH orig Reg *PH orig Reg
UE 12	2N371 2N372 2N603 2N754 2N755	RCA RCA GI TR TR	pnp, DR, ge pnp DR, ge pnp, DR, ge npn, PLE, si npn, PLE, si	30 30 *30 30 30	80 80 120 300 300	71 71 85 175 175	- 2 3 3	*24 *24 *30 *60 *100	10 10 - 50 50	80 80 *30-100 *15 *15	10 10 8 1	- *5 *10 *10	7 7 5 18 18	ТІ
HF 13	2N840 2N842 2N1224 2N1226 2N1395	TR TR RCA RCA RCA	npn,PLE,si npn,PLE,si pnp,DR,ge pnp,DR,ge pnp,DR,ge	30 30 30 30 30 30	300 300 120 120 120	175 175 85 85 100	3 2 - -	45 45 *40 *60 *40	50 50 - - 10	*30-100 *20-55 60 60 90	1 1 12 12 4	*15 10 - - *2	18 18 33 33 33 33	CDC AMP AMP SY, AMP
	2N1983 2N1984 2N1985 2N2225 2N3742	FA FA FA KSC MO	npn, DD, si npn, DD, si npn, DP, si pnp, ge npn, AE, si	*30 *30 *30 30 *30	2000 2000 2000 2000 200 5000	150 150 150 100 200	16 16 0.016 - 28.6	25 25 25 *15 300	- - - 400 50	100 80 60 *60 *20-200	1 1 1 25 0.2	*35 *35 *35 *14 *6	5 5 5 5	TRWS, CDC, AL TRWS, CDC, AL, AMP TRWS, CDC, AL, AMP
HF 14	2N3743 TN-55 TN-56 TN-57 TN-58	MO SPR SPR SPR SPR	pnp,AE,si npn,PE,si npn,PE,si npn,PE,si npn,PE,si	*30 30 30 30 30 30	5000 800 500 800 500	200 200 200 200 200 200	28.6 4.57 2.86 4.57 2.86	300 30 30 *40 *40	50 800 800 800 800	*25-250 100 100 80 80	0.3 .010 .010 0.010 0.010	*15 8 8 *8 *8	5 5 18 5 18	

WHAT GIVES YOU AN UNNEUTRALIZED, 3-STAGE TV-IF WITH 90db STABLE GAIN, HAS LOW FEEDBACK CAPACITANCE, CUTS COMPONENT COSTS, MINIMIZES ALIGNMENT TIME AND HAS NEVER BEEN USED IN A SINGLE TV SET?



36 Electronic Design



Integrated-Shield Transistors. How come they've never been used before? Simple. They've never been available before; they're brand new from Amperex.

Until now, the big problem in designing transistorized TV-IF's has been the transistor feedback capacitance. Amperex's breakthrough to integrated shielding has now produced the types A467 and A473 with feedback capacitance so low that the need for neutralizing the circuit is completely eliminated.

In the Amperex Integrated-Shielding process, we diffuse a special shield between the collector and the base lead

"tab" to clamp the base at the emitter RF potential. In common emitter circuits of the type used in TV-IF amplifiers the net effect is the elimination of the major source of feedback capacitance: the capacity between the collector and the base-lead "tab." Thus the $C_{\rm re}$ for the type A467 is a low 150 mpf and only 220 mpf for the type A473.

Now you can build a three-stage, unneutralized video IF amplifier, using the A467 and two A473's to produce an overall minimum stable gain of 90db at 44mHz. The gain control range of the type A467 stage is 55db minimum; in

the output stage the A473 will provide swings of 7.7 volts undistorted into 2700 ohms.

For complete data and application information, write: Amperex Electronic Corporation, Semiconductor and Special Purpose Tube Division, Slatersville, Rhode Island, 02876.

Туре	$\mathbf{f_T}$	Cre	45 Mc Useable Gain	
		150 mpf 230 mpf	33 db 34 db	- 36 db

Amperex

	7-59			ATT COLLEGE		MA	X. RATI	NGS		CHARA	CTERIST	ICS		
Cross Index Key	Type No.	Mfr.	Туре	fae *f _T (MHz)	P c (m₩)	T _j (°C)	mW/°C	YCEO *YCBO (V)	C (mA)	h _{fe} *h	CO *ICEO †ICEX (μΑ)	C _{oe} *C _{ob} (pF)	Package Outline (TO-)	Remarks
	2N1524 2N1525 2N1526 2N1527 2N1417	RCA RCA RCA RCA TR	pnp, DR, ge pnp, DR, ge pnp, DR, ge pnp, DR, ge npn, si	33 33 33 33 *34	80 80 80 80 150	71 71 71 85 150	- - - 1.25	*24 *24 *24 *24 15	10 10 10 10	60 60 130 130 60	16 16 16 16 0.05	- - *2 *1.5	1 40 1 40 5	
HF 15	2N1418 2N794 2N795 2N393 2N841	TR RCA RCA *SPR TR	npn,si pnp, ge pnp, ge pnp,MA,ge npn,PE,si	*34 *35 *35 40 40	150 150 150 25 300	150 85 85 100 175	1.25 - 0.63 3	30 *13 *13 *6 45	- 100 100 50 50	60 *50 *75 155 *60-400	.0.05 13 13 1.5 1	*1.5 *12 12 *3.5 *15	5 18 18 24 18	SPR SPR *PH orig Reg, GI TRWS, CDC
UE 16	2N843 2N1122 2N1122A 2N1300 2N1409	TR *SPR *SPR SPR RA	npn,PE,si pnp,MA,ge pnp,MA,ge pnp,ge npn,si	40 *40 *40 *40 *40	300 25 25 25 150 550	175 85 85 85 85 150	2 0.63 0.63 - 4.5	45 *12 *15 *13 *30	50 50 50 100 500	*45 - 150 35 35 36 30 *30	1 5 5 3 10	*10 6 6 - 35	18 24 24 5 5	*PH orig Reg *PH orig Reg GI
HF 16	2N1410 2N1638 2N3565 2N3566 2N3712	RA RCA FA FA TI	npn,si pnp,DR,ge npn,PL,si npn,PL,si npn,PL,si	*40 40 *40 *40 *40	550 80 500 800 800	150 85 125 125 175	4.5 - 5.0 8.0 5.33	*30 *34 25 30 150	500 10 - - 200	*30 - *150-600 *400 *30-150	10 - 0.05 0.05 0.1	35 - *4.0 25 9	5 1 - - 5	GI CDC, IEC, GME CDC, IEC, GME Metal header, MO
UE 17	PADT50 2N128 2N1631 2N1632 2N1637	AMP *SPR RCA RCA RCA	pnp,PADT,ge pnp,SBT,ge pnp,DR,ge pnp,DR,ge pnp,DR,ge	*40 45 45 45 45	6000 25 80 80 80	75 85 85 85 85	- 0.82 - - -	*70 *10 *34 *34 *34	700 5 10 10 10	40 40 80 80 48	- 0.6 16 16 -	*2.5 - - -	3 24 40 1 1	*PH orig Reg
HF 17	2N1639 2N2509 2N2510 2N2511 OC44	RCA AL AL AL AMP	pnp, DR, ge DP DP DP pnp, PADT, ge	45 45 45 45 *45	80 1.2w 1.2W 1.2W 83	85 200 200 200 200 75	6.9 6.9 6.9	*34 80 65 50 *15	10 - - - 5	- 40 150 240 100	- .005 .005 .005 0.5	- *6 *6 *6	1 18 18 18 -	GI, TR, AMP, UC GI, TR, AMP, UC GI, TR, AMP, UC Special Case
UF 10	2N504 2N604 2N605 2N606 2N607	*SPR GI GI GI	pnp,MD,ge pnp,DR,ge pnp,DR,ge pnp,DR,ge pnp,DR,ge	50 *50 *50 *50 *50	30 120 120 120 120	85 85 85 85 85	0.75 2 2 2 2 2	*35 *30 *15 *15 *15	50 - - - -	16 *40-140 40 60 80	10 8 10 10 10	*2.5 *5 *7 *7 *7	1 5 5 5 5	*PH orig Reg, GI TI
HF 18	2N796 2N844 2N845 2N1409 2N1410	RCA TR TR TRWS TRWS	pnp, ge npn,PLE,si npn,PLE,si npn,PL,si npn,PL,si	*50 50 50 *50 *50	150 300 300 600 600	85 175 175 175 175	3 3 4 4	*13 *60 *100 **30 *45	100 50 50 500 500	*85 *40-120 *40-120 *15-45 *30-90	13 1 1 10 10	*12 *10 10 35 24	18 18 18 5 5	SPR GI GI
	2N1427 2N1683 2N1752 2N1785 2N1786	*SPR RCA *SPR *SPR *SPR	pnp,MA,ge pnp,ge pnp,MD,ge pnp,MD,ge pnp,MD,ge	*50 *50 50 50 50	25 150 60 45 45	85 85 100 85 85	0.8 0.75 0.75	*6 12 *12 *10 *10	50 100 50 50 50	120 *50 250 150 250	0.5 3 0.8 2	*3.5 *12 *1.0 *1.5 *1.7	24 5 9 9	*PH orig Reg, GI SPR *PH orig Reg *PH orig Reg *PH orig Reg
HF 19	2N1787 2N1864 2N1893 2N1978 2N1986	*SPR *SPR FA FA FA	pnp,MD,ge pnp,MD,ge npn,si npn,DP,si npn,DD,si	50 50 50 *50 *50	45 60 3 3000 2000	85 100 200 200 150	0.017 172	*15 *20 80 *60 25	50 50 0.5 -	120 60 *40-120 *30 150	1.5 1.5 0.01 1	*1.5 *1.6 *15 *70 *25	9 9 5 - 5	*PH orig Reg *PH orig Reg RCA, TR, NA, TRWS TRWS, CDC, GI, AL, AMP
HF 20	2N1987 2N1988 2N1989 2N2427 2N1900	FA FA FA TR TRWS	npn,DD,si npn,DD,si npn,DD,si npn,PE,si npn,PL,si	*50 *50 *50 50 *>50	2000 2000 2w 500 125000	150 150 150 175 175	16 16 16 2.86 1000	25 45 45 40 *140	- - - 50 10000	50 *75 *40 40 5.0	1 1 1 .5 10000	*25 *17 *17 *8 *1000	5 5 5 18 38	TRWS, CDC. GI, AL, AMP TRWS, CDC, GI, AL TRWS, CDC, GI, AL Single Ended
nr zu	2N1903 2N2223 2N2223A T1538 2N346	TRWS MO MO TI SPR	npn,PL,si npn,AE,si npn,AE,si pnp,PE pnp,SBT,ge	*>50 *50 *50 *50 *50 60	125000 3000 3000 200 20	150 200 200 125 55	1000 17.2 17.2 2 1.33	*140 60 60 32 *5	10000 500 500 50 50	5.0 *25-150 *25-150 25 35	10000 .01 .01 0.1 0.7	*1000 *15 *15 *0.5 *3	39 77 77 92 24	Double Ended Diff, Amp. Diff, Amp. *PH orig Reg
	2N370 2N698 2N717	RCA FA FA	pnp,DR,ge npn,DP,si npn,DD,si	60 *60 *60	80 3.0W 1.5W	71 200 175	- 17.2 10	*24 60 *60	10 - -	100 *40 *40	10 0.0005 0.01	- *13 *17	7 5 18	TRWS, TR, STC, AMP, CDC TRWS, CDC, TR, GI, AMP,
HF 21	2N719	FA	npn, DD, si	*60	1.5W	175		*120	-	*40	0.01	*12	18	TRWS, CDC, TR, GI, AMP
	2N719A 2N720A	FA FA	npn, DP, si npn, DP, si	*60 *60	1.8W 1.8W	200 200	10.3	*120 *120	Ξ	*40 *80	0.005 0.005	*12 *12	18 18	TRWS, CDC, AMP, AL, GI, TR TRWS, CDC, GI, AMP, AL, TR, RCA
	2N912 2N1301	FA SPR	npn,DP,si pnp,ge	*60 *60	1800 150	200 85	10.3	60 *13	100	45 30	0.005	*13	18 5	TRWS, CDC, AMP, AL

						M	AX. RATI	NGS		CHAR	ACTERISTI	CS		A super the state of
Cross Index Key	Type No.	Mfr.	Туре	fae ' *fT (MHz)	P c (mW)	т _; (°с)	mW/°C	*VCEO *VCBO (V)	1 _C (mA)	h _{fe} *h	ICO *ICEO †ICEX (µA)	C _{oe} *C _{ob} (pF)	Package Outline (TO-)	Remarks
HF 22	2N 1972 2N 1975 2N 2060 2N 2060A 2N 2595	FA FA MO MO SSD	npn,DD,si npn,DP,si npn,AE,si npn,AE,si pnp,PL	*60 *60 *60 *60 *60	2,0 3W 3000 3000 400	175 200 200 200 200 200	10 17.2 17.2 17.2 2.3	*60 60 60 60	- 500 500 50	*250 45 *40-120 *40-120 *15	0.1 0.005 .002 .002	*25 *13 *15 *15 *6	5 5 77 77 46	TR, AMP, TRWS TRWS, CDC, AL, TR, AMP Diff. Amp. Diff. Amp.
nr 22	2N2598 2N2601 2N2980 2N2981 2N3567	SSD SSD FA FA FA	pnp,PL pnp,PL npn,DP,si npn,DP,si npn,PE,si	*60 *60 *60 *60 *60	400 400 750 750 800	200 200 200 200 200 125	2.3 2.3 4.3 4.3 8.0	80 60 60 60 40	50 50 500 500	*15 *12.5 *100 *100 *80	.025 .025 0.0001 0.0001 0.05	*6 *6 *8. *8 *20	46 46 18 18	GI GI TEC, GME
U.S. 0.0	2N3568 2N3569 MM2483 MM2484 2N2483	FA FA MO MO FA	npn,PE,si npn,PE,si npn,EP,si npn,EP,si npn,DP,si	*60 *60 *60 *60 *69	800 800 1200 1200 1.2W	125 125 200 200 200	8.0 8.0 6.9 6.9	60 40 60 60	- 50 50 50	*80 *150 *40-120 *100-500 *280	0.05 0.05 .01 .01 0.0001	*20 *18 *6 *6 *3.5	- 18 18 18	IEC, GME AMP, GI, TR, AL, UC
HF 23	2N911 2N1335 2N1336 2N1337 2N1338	FA TRWS TRWS TRWS TRWS	npn,DP,si npn,PL,si npn,PL,si npn,PL,si npn,PL,si	*70 *70 *70 *70 *70	1800 800 800 800 800	200 175 175 175 175 175	10.3 5.3 5.3 5.3 5.3	60 *120 *120 *120 *80	300 300 300 300 300	70 *10-150 *10-150 *10-150 *10-150	0.005 1 1 1 1	*13 *8 *10 *8 *10	18 5 5 5 5	TRWS, CDC, AMP, AL
	2N1339 2N1340 2N1341 2N1342 2N1505	TRWS TRWS TRWS TRWS TRWS	npn,PL,si npn,PL,si npn,PL,si npn,PL,si n pn, PL,si	*70 *70 *70 *70 *70 *>70	800 800 800 800 3W	175 175 175 175 175 175	5.3 5.3 5.3 5.3 20	*120 *120 *120 *150 *50	300 300 300 300 300 500	*10-150 *10-150 *10-150 *12 1.0	1 1 1 10 50	*8. *8 *8 *8, *10	5 5 5 5 5	NUC
HF 24	2N2092 2N2093 2N2914 2N2915 2N2916	AMP AMP FA FA FA	pnp,PADT,ge pnp,PADT,ge npn,DP,si npn,DP,si npn,DP,si	*70 *70 *70 *70 *70	83 1.5W 1.5W 1.5W	85 85 200 200 200	0.6 1.7 3.42 3.42 3.42 3.42	*25 *25 45 45 45	10 10 30 30 30	150 150 *450 *240 *450	- 0.001 0.001 0.001	- *5 *5 *5	7 7 5 5 5	SPR, GI, AL, UC, MO GI, AL, UC, MO, SPR SPR, GI, AL, UC, MO
NE OF	2N2917 2N2918 2N2919 2N2920 2N2972	FA FA FA FA	npn,DP,si npn,DP,si npn,DP,si npn,DP,si npn,DP,si	*70 *70 *70 *70 *70	1.5W 1.5W 1.5W 1.5W 750	200 200 200 200 200 200	3.42 3.42 3.42 3.42 1.71	45 45 60 60 45	30 30 30 30 30	*240 *450 *240 *450 *240	0.001 0.001 0.001 0.001 0.001	*5 *5 *5 *5 *5	5 5 5 18	SPR, GI, UC, RCA, AL, MO SPR, GI, UC, RCA, AL, MO SPR, GI, AL, UC, MO SPR, GI, AL, UC, MO GI, AL, UC, MO, SPR
HF 25	2N2973 2N2974 2N2975 2N2976 2N2977	FA FA FA FA	npn,DP,si npn,DP,si npn,DP,si npn,DP,si rfpn,DP,si	*70 *70 *70 *70 *70	750 750 750 750 750 750	200 200 200 200 200 200	1.71 1.71 1.71 1.71 1.71	45 45 45 45 45	30 30 30 30 30	*450 *240 *450 *240 *450	0.001 0.001 0.001 0.001 0.001	*5 *5 5 *5	18 - 18 18 18	GI,AL,UC,MO,SPR GI,AL,UC,MO,SPR,VEC GI,AL,UC,MO,SPR,VEC GI,AL,UC,MO,SPR GI,AL,UC,MO,SPR
UE oc	2N2978 2N2979 2N2982 2N3056 2N3019	FA FA FA RA	ripn, DP, si npn, DP, si hpn, DP, si npn, PL, EP npn, PL, EP	*70 *70 *70 *70 *70 *70	450 750 750 400 800	200 200 200 300 300	1.71 1.71 4.3 2.3 4.6	60 60 60 60 80	30 30 500 1000 1000	*240 *450 *100 *40 *100	0.001 0.001 0.0001 .010 .010	5 *5 *8 *12 *12	18 18 18 46 5	GI, AL, UC, MQ, SPR, VEC GI, AL, UC, MO, SPR, VEC GI MO, TRWS
HF 26	2N3020 2N3057 2N3075 2N990 2N993	RA RA AMP AMP AMP	npn,PL,EP npn,PL,EP pnp,PADT,ge pnp,PADT,ge pnp,PADT,ge	*70 *70 70 75 *75	800 400 140 67 67	300 300 90 75 75	4.6 2.3 3.1 1.33 1.7	80 60 30 *32 *32	1000 1000 20 10	*40 *100 27 150 150	.010 .010 10 -	*12 *12 3 -	5 46 12 18 18	MO, TRWS 4 Lead 4 Lead
HF 27	2N2089 2N2590 2N2671 2N2672 2N696	AMP SSD AMP AMP FA	pnp,PADT,ge pnp,PL pnp,AD,ge pnp,AD,ge npn,DD,si	75 *75 75 75 *80	100 400 100 100 2.0W	85 200 75 85 175	0.6 2.3 0.6 0.6 13.3	*32 60 *32 *32 *60	10 50 10 10	150 *20 150 150 *40	- .025 8 8 0.01	- *6 2.5 2.5 *20	7 46 12 39 5	Veb=1 Volt TRWS, TR, GI, AMP, CDC, NA ,
21	2N699 2N718	FA FA	npn,DD,si npn,DD,si	*80 *80	2.0W 1.5W	175 175	13.3 10	*120 *60	-	*80 *75	0.01 0.01	12 *17	5 18	TRWS, SY, TR, GI, AMP, CDC, NA, RCA TRWS, CDC, SY, TR, GI, AMP, AL, NA, MO
	2N718 A 2N720 2N870 2N910	FA FA FA	npn,DP,si prp,DD,si npn,DP,si npn,DP,si	*80 *80 *80 *80	1.8W 1.5W 1.8W 1800	200 175 200 200	10.3 10 10.3 10.3	*75 *120 60 60	-	*80 *80 *75 140	0.003 0.01 0.004 0.005	*18 12 *13 *13	18 18 18 18	CDC, MO, TR, GI, AMP, AL, NA, RCA, TRWS FRWS, CDC, TR, GI, AMP, AL TRWS, CDC, GI, AMP, AL TRWS, CDC, AMP, AL
HF 28	2N1252 2N1613 2N1748 2N1749	FA FA *SPR *SPR	npn, DD, si npn, DP, si pnp, MD, ge pnp, MD, ge	*80 *80 *80 *80	2.0W 3W 60 75	175 200 100 100	13.3 17.2 0.8 1.0	*30 *75 *25 *40	- - 50 10	*35 *80 45 45	0.1 0.003 1.5 1.5	*30 *18 *1.3 *1.3	5 5 9	AL, NA, GI TRWS, CDC, MO, TR, GI, AMP, AL, RCA *PH orig Reg *PH orig Reg

(see pages 4-9 for explanation of company abbreviations.)

May 17, 1966

						MA	X. RATI	NGS		CHARA	CTERISTI	CS		
Cross Index Key	Type No.	Mfr.	Туре	fae *f _T (MHz)	P c (mW)	T _j (°C)	mW/°C	*VCEO *VCBO (V)	1 _C (mA)	h _{fe} *h	lC0 *lCE0 †lCEX (μA)	C _{oe} *C _{ob} (pF)	Package Outline (TO-)	Remarks
HE 90	2N1973 2N2451 2N2720 2N2721 T1537	FA SPR SSD SSD TI	npn,DP,si pnp,MAT,ge npn,PL - pnp,PE	*80 *80 *80 *80 *80	3W 25 600 600 200	200 85 200 200 125	4.56 4.54 3.4 3.4 2	60 *6 60 60 32	50 50 50 50	140 40 *35 *35 45	0.005 5 .010 .010 0.1	*13 6 - *6 *0.5	5 24 5 5 92	TRWS, CDC, AL, AMP, TR Differential amp, AL, SPR Differential amp, AL, SPR
HF 29	2N501 2N2188 2N2190 2N2596 2N2599	*SPR TI TI SSD SSD	pnp,MD,ge pnp,AD,ge pnp,AD,ge pnp,PL pnp,PL	*90 *90 90 *90 *90	60 125 125 400 400	100 85 85 200 200	0.8 2.1 2.1 2.3 2.3	*15 *40 *60 60 80	50 30 30 50 50	*35 90 90 *30 *30	1 1.0 1.0 .025 .025	*1.5 *1.6 *1.6 *6 *6	1 58 58 46 46	*PH orig Reg, GI
HF 30	2N2602 2N4104 2N384 2N697	SSD TI RCA FA	pnp,PL npn,PL,si pnp,DR,ge npn,DD,si	*90 *90 100 *100	400 300 120 2.0W	200 175 100 175	2.3 2 - 13.3	60 60 40 *60	50 50 -	*25 *400 60 *75	.025 0.01 12 0.01	*6 4.5 - *20	46 18 44 -	TRWS, MO, TR, GI, AMP, CDC, BE NA, RCA
HF 30	2N728 2N729 2N871 2N956	TR TR FA	npn,PE,si npn,PE,si npn,DP,si npn,DP,si	100 100 *100 *100	300 300 1.8W	175 175 200 200	4 4 10.3	15 30 60 *75	100 100 10A	*20-200 *20-200 *30	5 5 0.004 0.003	*12 12 *13 *18	18 18 18	TRWS, CDC, GI, AMP, AL NA, RCA, AMP TRWS, CDC, MO, GI, AMP
	2N979 2N980 2N987 2N1180 2N1225	SPR SPR AMP RCA RCA	pnp,MD,ge pnp,MD,ge pnp,PADT,ge pnp,DR,ge pnp,DR,ge	*100 *100 100 100 100	60 60 86 80 120	100 100 90 71 85	0.8 0.8 1.33	*20 *20 *40 *30 *40	100 100 10 10	*70 *70 100 100 60	1 1 1 - 12 12	*1.5 *1.5 - -	18 18 18 45 33	4 Lead AMP
HF 31	2N1396 2N1420	RCA FA	pnp,DR,ge npn,DD,si	100 *100	120 2W	100 175	- 13.3	*40 *60	10 -	90 *200	4 0.01	*2 17	33 5	SY, AMP TRWS, CDC, MO, TR, GI, AMP,
	2N1499A 2N1711	*SPR FA	pnp,MD,ge npn,DP,si	*100 *100	60 2W	100 200	0.8 17.2	*20 *75	100	*70 *130	1 .003	*1.5 *18	9 5	*PH orig Reg, GI TRWS, CDC, MO, TR, GI, AL
	2N1726 2N1727 2N1728 2N1746 2N1747	*SPR *SPR *SPR *SPR *SPR	pnp,MD,ge pnp,MD,ge pnp,MD,ge pnp,MD,ge pnp,MD,ge	100 100 100 100 100	60 60 60 60	100 100 100 100 100	0.8 0.8 0.8 0.8	*20 *20 *20 *20 *20 *20	50 50 50 50 50	60 *60 *60 70 70	1.5 1.5 1.5 1	*1.5 *1.5 *1.5 *1.2	9 9 9 9	*PH orig Reg *PH orig Reg *PH orig Reg *PH orig Reg *PH orig Reg
HF 32	2N1748A 2N1788 2N1789 2N1790 2N1893A	*SPR *SPR *SPR *SPR TRWS	pnp,MD,ge pnp,MD,ge pnp,MD,ge pnp,MD,ge npn,PL,si	*100 100 100 100 *>100	60 60 60 60 3W	100 100 100 100 200	0.8 0.8 0.8 0.8 17.14	*25 *35 *35 *35 *140	50 50 50 50 50 50	70 150 200 120 *40-120	1.5 1.5 1.5 1.5 .01	*1.3 *1.5 *1.5 *1.5 *1.5	9 9 9 9 5	*PH orig Reg *PH orig Reg *PH orig Reg *PH orig Reg GI, TR
	2N 1958 2N 1958A 2N 1959 2N 1959 2N 1959A 2N 1964	SY SY SY SY SY	npn,PE,si npn,PE,si npn,PE,si npn,PE,si npn,EP,PL,si	*100 *100 *100 *100 *100	600 600 600 600 400	175 175 175 175 175 175		*60 *120 *60 *120 *60	500 500 500 500 500	*20-60 *20-60 *40-120 *40-120 *20-60	0.5 300 0.5 0.5 0.5	18 18 18 18 18	5 5 5 5 46	GI GI SY, GI, NA GI, NA NA
HF 33	2N1965 2N2084 2N2330 2N2331 2N2405	SY AMP MO MO RCA	npn,EP,PL,si pnp,PADT,ge npn,PE,si npn,PE,si npn,si	*100 100 *100 *100 *100	400 125 3W 1.8W 5W	175 90 175 175 200	1.93 5.33 3.33 28.6	*60 *40 *30 *30 *120	500 10 - - 1000	40-120 100 *50 *50 *60-200	0.5 - 0.001 0.001 0.01	18 - *10 *10 *15	46 33 5 5 5	NA GI, MO, TRWS
	2N2591 2N2722 2N2895 2N2896 2N2897	SSD SSD RCA RCA RCA	pnp,PL npn,PL npn,si npn,si npn,si	*100 *100 *100 *100 *100	400 600 1800 1800 1.8W	200 200 200 200 200 200	2.3 3.4 10.3 10.3 10.3	60 45 65 90 45	50 50 1000 1000 1a	*35 *60 *40·120 *60·200 *50·200	.025 .001 .002 .01	*6 *6 *15 *75 *15	46 5 18 18 18	Differential AMP, AL, SPR
HF 34	2N2898 2N2899 2N2900 2N2947 2N2948	RCA RCA RCA MO MO	npn,si npn,si npn,si pnp,EP,si npn,EP,si	*100 *100 *100 *100 *100	1800 1800 1800 25W 25W	200 200 200 175 175	10.3 10.3 10.3 167 167	65 90 45 *60 *40	1000 1000 1000 1.5 1.5	*40-120 *60-200 *50-200 2.5-35 2.5-100	.002 .01 .05 1	*75 *15 *15 *60 *60	46 46 46 3 3	
	2N2949 2N2950 2N3702 2N3703 2N3704	MO MO TI TI TI	npn,EP,si npn,EP,si pnp,PL,si pnp,PL,si npn,EP,si	*100 *100 *100 *100 *100	6W 6W 300 300 300	175 175 125 125 125 150	40 40 3 3 3	*60 *60 25 25 20	.7 .7 200 200 800	5-100 5-100 *60-300 *50-150 *90-330	.1 0.1 0.1 0.1	*20 *20 *12 *12 12	11111	Plas IEC, GME Plas IEC, GME Plas IEC, GME
HF 35	2N3705 2N3706 2N3798 2N3799 2N3800	TI TI MO MO MO	npn,EP,si npn,EP,si pnp,AE,si pnp,AE,si pnp,AE,si	*100 *100 *100 *100 *100	300 300 1200 1200 360	150 150 200 200 200 200	3 3 6.9 6.9 2.06	30 20 60 60 60	800 800 50 50 50	*45-165 *30-660 *150-450 *300-900 *150-450	0.1 0.1 .01 .01	12 12 *4 *4 *4	- 18 18 71	Plas IEC, GME Plas IEC, GME Dual

WHICH BRANCH

OF THE PNP SILICON TRANSISTOR FAMILY TREE



ARE YOU CONCERNED WITH?

PNP LOW LEVEL LOW NOISE $^{1}CBO < 1 \text{ nA}$ $^{h}FE (10 \, \mu \text{ A-5V}) \, 100-300$ NF 3 db PNP MEDIUM POWER $^{BV}EBO > 60V$ $^{h}FE (.1 \text{ mA to } 100 \text{ mA}) > 100$ $^{t}TCT < 100 \text{ N SEC}$ PNP INTEGRATED CHOPPERS $^{BV}EE > 50V$ $^{V}O < 50 \, \mu V$ $^{I}EEO < 1 \text{ nA}$

2N2603 2N2604 2N2 2N2605 2N2 2N3544 2N2904A 2N3548 2N3502 2N3549

2N2485A 2N2486A 2N2904A — 2N2907A 2N3502 — 2N3505

3N90 — 3N95 3N114 — 3N119 2N328A 2N329A 2N2944 2N2945 2N2946 2N3857 2N3058 — 2N3065

DIFFUSED

EPITAXIAL

BV CEO > 50V

hFE > 50

ICBO < 10 nA

BVCBO

BVEBO

DIFFERENTIAL AMPLIFIERS hfe > 100

 $\frac{h_{FE}}{h_{FE_2}}$ 10% VBE₁-VBE₂ = ± 3 mV

NS7200 NS7201 2N3502 2N3503 2N3504 2N3505 2N3800 — 2N3811

NSC-130

Whichever branch of PNP's you are concerned with, before you specify a brand CHECK THE NSC LINE. Write for spec sheets on any of these devices—or better yet, the NSC Composite Catalog.



						MA	X. RATI	NGS		CHARA	CTERISTIC	CS		
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (MHz)	P c (mW)	T _j (°C)	mW/°C	*VCEO *VCBO (V)	I _C (mA)	h _{fe} *h	ICO *ICEO †ICEX (μΑ)	C _{oe} *C _{ob} (pF)	Package Outline (TO-)	Remarks
	2N3801 2N3802 2N3803 2N3804 2N3805	MO MO MO MO	pnp,AE,si pnp,AE,si pnp,AE,si pnp,AE,si pnp,AE,si	*100 *100 *100 *100 *100	360 360 360 360 360	200 200 200 200 200 200	2.06 2.06 2.06 2.06 2.06 2.06	60 60 60 60	50 50 50 50 50	*300-900 *150-450 *300-900 *150-450 *300-900	.01 .01 .01 .01	*4 *4 *4 *4 *4	71 71 71 71 71 71	Dual Diff. Amp. Diff. Amp. Diff. Amp. Diff. Amp.
HF 36	2N3806 2N3807 2N3808 2N3809 2N3810	MO MO MO MO	pnp,AE,si pnp,AE,si pnp,AE,si pnp,AE,si pnp,AE,si	*100 *100 *100 *100 *100	600 600 600 600	200 200 200 200 200 200	3.4 3.4 3.4 3.4 3.4	60 60 60 60	50 50 50 50 50	*150-450 *300-900 *150-450 *300-900 *150-450	.01 .01 .01 .01	*4 *4 *4 *4 *4	77 mod 77 mod 77 mod 77 mod 77 mod	Dual; Low Profile Can Dual; Low Profile Can Diff. Amp.; Low Profile Can Diff. Amp.; Low Profile Can Diff. Amp.; Low Profile Can
	2N3811 40084 40354 FT34A FT34B	MO RCA RCA FA FA	pnp,AE,si npn,si npn,si npn,DPE,si npn,DPE,si	*100 *100 *100 100 100	600 1.8W 500	200 200 175 200 200	3.4 10 3.3 .0286 .0286	60 40 *150 *150 *120	50 1a 50 -	*300-900 *50-250 - *120 *300	.01 0.25 .005 (ma	*4 15 x) 2.8 1.2 1.2	77 mod 18 - 59 59	Diff. Amp.; Low Profile Can
HF 37	NS1355 MCS2135 MCS2136 MCS2137 NS1356	NA MO MO MO NA	npn,PL,si npn,AE,si npn,AE,si pnp,AE,si npn,PL,si	*100 *100 *100 *100 *100	600 150 150 150 800	200 125 125 125 200	3.5 1.5 1.5 1.5 4.5	40 60 60 60 40	100 50 50 50 50	*30-100 *100-300 *250-750 *100-300 *30-100	.025 .01 .01 .02 .025	*7 *3 *3 *3 *7	18 - - - 5	VHF 400mW @ 70 Hz
	MCS2138 T1411 TN-53 TN-54 TN-59	MO TI SPR SPR SPR	pnp,AE,si npn,EP,si npn,PE,si npn,PE,si npn,PE,si	*100 *100 100 100 100	150 300 800 800 800	125 150 200 200 200 200	1.5 2.4 4.57 2.86 4.57	60 30 45 45 30	50 800 800 800 800	*250-750 *180-660 *50 *50 *100	.02 0.1 .010 .010 .020	*3 *12 8 8 8	1 5 5 5	Plas IEC, GME
HF 38	TN-60 TN-61 TN-62 TN-63 TN-64	SPR SPR SPR SPR SPR	npn, PE, si npn, PE, si npn, PE, si npn, PE, si npn, PE, si npn, PE, si	100 100 100 100 100	500 800 500 800 500	200 200 200 200 200 200	2.86 4.57 2.86 4.57 2.86	30 30 30 20 20	800 800 800 800 800	*100 30 30 20 20	.020 .020 .020 0.1 0.1	8 8 8 8	18 5 18 5 18	
	TN-237 TN-238 2N1253 2N2189 2N2191	SPR SPR FA TI TI	npn, PE, si npn, PE, si npn, DD, si pnp, AD, ge pnp, AD, ge	100 100 *110 110 110	800 500 2.0W 125 125	200 200 175 85 85	4.57 2.86 13.3 2.1 2.1	*35 *35 *30 *40 *60	800 800 - 30 30	30 30 *45 135 135	1 0.1 1.0 1.0	*8 *8 *30 *1.6 *1.6	5 18 5 58 58	AL, NA
HF 39	2N501A 2N1023 2N1066 2N1397 2N1500	*SPR RCA RCA RCA *SPR	pnp,MD,ge pnp,DR,ge pnp,DR,ge pnp,DR,ge pnp,MD,ge	*120 120 120 120 120 *120	60 120 120 120 120 60	100 100 100 100 100	0.8 - - - 0.8	*15 40 *40 *40 *15	50 - - 10 50	*100 60 *60 90 *50	1 12 12 4 1	*1.5 - - *2 *1.5	1 44 33 33 9	*PH orig Reg, GI AMP KSC SY, AMP *PH orig Reg, GI
	2N2597 2N2600 2N2603 2N2798 2N2799	SSD SSD SSD SPR SPR	pnp,PL pnp,PL pnp,PL pnp,ED,ge pnp,ED,ge	*120 *120 *120 *120 *120 *120	400 400 400 75 75	200 200 200 100 100	2.3 2.3 2.3 1	60 80 60 *60 *30	50 50 50 100 100	*60 *60 *50 *50 *50	.025 .025 .025 -	*6 *6 *6 *2.5 *2.5	46 46 46 9	
∯F 40	2N2837 2N2838 2N2943 2N1710 2N768	MO MO SPR TRWS *SPR	pnp,EP,si pnp,EP,si pnp,ED,ge npn,PL,si pnp,MD,ge	*120 *120 *120 *120 *>120 *124	1.8W 1.8W 150 15000 35	200 200 100 175 100	10.3 10.3 2 100 0.467	35 35 *30 *60 *12	800 800 100 2000 100	*30-90 *75-225 *50 4.0 *40	- - 50 1	*25 *25 *2.5 *40 *1.6	18 18 9 8 18	*PH orig Reg
	2N2592 40340 40341 SFT443A 2N2193A	SSD RCA RCA NUC GE	pnp,PL npn,si npn,si npn,si npn,PE,si	*125 *125 *125 *125 *130	400 70W 70W 12,000 2.8W	200 200 200 - 200	2.3 400 400 - 1.6	60 - - 80 50	50 10A 10A - 1A	*70 - - *15 *40-120	.025 *100 *100 10 .01	*6 *120 *85 20 *20	46 60 60 60 5	Vcev= 60; overlay type Vcev= 80; overlay type CDC, GI, FA, NA, MQ AL
HF 41	2N2194A 2N2195A 2N2243A 2N2350A 2N2351A	GE GE GE GE	npn,PE,si npn,PE,si npn,PE,si npn,PE,si npn,PE,si	*130 *130 *130 *130 *130	2.8W 2.8W 2.8W 5,000 5,000	200 200 200 200 200 200	16 16 16 28.5 28.5	40 25 80 25 50	1A 1A 1a 1,000 1,000	*20-60 20 *40-120 *20 *40-120	.010 0.01 .01 .01 .01	*20 *20 *20 *20 *20 *20	5 5 5 46 46	CDC, FA, GI, NA, MO, AL CDC, FA, GI, MO, AL GI
UE 10	2N2352A 2N2353A 2N2364A 2N3843 2N3843A	GE GE GE GE	npn,PE,si npn,PE,si npn,PE,si npn,PE,si npn,PEP,si	*130 *130 *130 *135 *135	5,000 5,000 5,000 200 200	200 200 200 100 100	28.5 28.5 28.5 2.67 2.67	40 25 80 30 30	1,000 1,000 1,000 1,000 100	*20-60 *20 *40-120 20-40 *20-40	.01 .01 .01 0.5 0.5	*20 *20 *20 *2.8 *2.8	46 46 46 98 98	NA NA CDC, NA 10.5 d B (max rf nf) 8.5 d B (max rf nf)
HF 42	2N3844 2N3844A 2N3845 2N3845A 2N1177	GE GE GE RCA	npn,PE,si npn,PEP,si npn,PE,si npn,PEP,si pnp,DR,ge	*135 *135 *135 *135 *135 140	200 200 200 200 200 80	100 100 100 100 71	2.67 2.67 2.67 2.67	30 30 30 30 *30	100 100 100 0.5 10	35-70 *35-70 60-120 *60-120 100	0.5 0.5 0.5 0.5 12	*2.8 *2.8 *2.8 *2.8	98 98 98 98 45	10.5 d B (max rf nf) 8.5 d B (max rf nf) 10.5 d B (max rf nf) 8.5 d B (max rf nf) LAN

						MA	X. RATI	NGS		CHARA	ACTERISTI	CS		
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (MHz)	P c (mW)	T _j (°C)	mW/°C	*V CBO (V)	1 _C (mA)	h _{fe} *h	¹ C0 * ¹ CE0 † ¹ CEX (μA)	C _{oe} *C _{ob} (pF)	Package Outline (TO-)	Remarks
HF 43	2N1178 2N1179 2N1506 2N1506A 2N2874	RCA RCA TRWS TRWS TRWS	pnp,DR,ge pnp,DR,ge npn,PL npn,PL,si npn,PL,si	140 140 *>140 *>140 *>140 *140	80 80 3W 3.5W 15000	71 71 175 200 175	- 20 20 100	*30 *30 *60 *80 *75	10 10 500 500 2000	40 80 2 2 2	12 12 10 .05 10	- *10 *10 *40	45 45 5 8	LAN LAN NUC
HF 43	2N2781 2N2782 2N2783 2N702 2N703	TRWS TRWS TRWS TI TI	npn,PL,si npn,PL,si npn,PL,si npn,si npn,si	*>140 *>140 *>140 *>150 *150	15000 15000 15000 300 300	175 175 175 175 175 175	100 100 100 2 2	*75 *100 *100 25 25	2000 2000 2000 50 50	2 2. 2 *20 *40	500 500 10 0.5 0.5	*40 *40 *40 *3 *3	8 8 8 18 18	TRWS, GI, NA TRWS, FA, SY, GI, NA
	2N758B 2N995 2N1499B 2N1709 2N2048	SSD FA SPR TRWS *SPR	npn,PL pnp,PE,si pnp,ED,ge npn,PL,si pnp,MD,ge	*150 *150 *150 *150 *150	500 1.2W 75 15000 150	200 200 100 175 100	2.85 6.9 1 100 2	60 15 *30 *75 *20	50 - 100 2000 100	*12.5 *70 *70 5 *125	.005 0.001 0.6 10	*6 *8 *2.5 *40 *1.5	18 18 9 8 9	MO, TR NUC *PH orig Reg
HF 44	2N2048 A 2N2400 2N2520 2N2593 2N2604	*SPR *SPR SSD SSD SSD	pnp,MD,ge pnp,MD,ge npn,PL pnp,PL pnp,PL	*150 *150 *150 *150 *150 *150	150 150 400 400 400	100 100 200 200 200	2 2 2.3 2.3 2.3	*30 *12 60 60 45	100 100 50 50 50	*50 *30 *12.5 *100 *60	3 .005 .025 .010	3 4 *6 *6 *6	9 18 46 46 46	*PH orig Reg *PH orig Reg TI, AL, UC
	2N2654 2N2797 2N2927 2N2942 2N3081	AMP SPR FA SPR SY	pnp,AD,ge pnp,ED,ge pnp,PE,si pnp,ED,ge pnp,EP,PL,si	150 *150 *150 *150 *150	100 75 3000 150 600	75 100 200 100 175	0.5 1 4.56 2	*32 *40 25 *50 *70	10 100 - 100 600	50 *80 *60 *80 *30-90	8 - 0.001 - .01	*1.5 *2.5 *12 *2.5 13	12 9 5 9 5	
HF 45	2N3081/46 2N3081/51 2N3245 2N3262 2N3638	SY SY MO RCA FA	npn,PL,EP,si npn,PL,EP,si pnp,ED,si npn,si pnp,PE,si	*150 *150 *150 *150 *150	400 300 5W 8.75W 700	175 175 200 200 125	- 28.6 5.71 7.0	*70 *70 50 80 25	600 600 1A 1.5A 500	*30-90 *30-90 *30-90 3 *40	.01 .01 .050 0.1 0.0001	13 13 *25 *20 *12	46 51 5 39	TI IEC, GME
	2N3763 2N3765 2N3818 SFT440 2N1499A	MO MO MO NUC PH	pnp,AE,si pnp,AE,si npn,EP,si npn,si pnp,ge	*150 *150 *150 *150 *160	4000 2000 25000 12,000 60	200 200 175 - 100	22.8 11.4 167 - 0.8	60 60 *60 80 *20	1500 1500 2000 1000 100	*20-80 *20-80 *5 - 50 *10 *70	- 1 10 0.6	*15 *15 *40 15 *1.5	5 46 60 60 9	cex=0.1 cex=0.1
HF 46	2N 3962 2N 3963 2N 3964 2N 3965 40263	FA FA FA RCA	pnp,DP,si pnp,DP,si pnp,DP,si pnp,DP,si pnp,DR,ge	160 160 160 160 160	1.2 W 1.2 W 1.2 W 1.2 W 1.2 W	200 200 200 200 200 100	6.85 6.85 6.85 6.85 2.66	60 80 45 60 *20	50 50 50 50 50	*300 *300 *500 *500 12	- - - - 10	*6 *6 *6 *6	18 18 18 18 1	
	2N2525 A301 2N2913 2N735A 2N739A	TRWS AMP FA SSD SSD	npn,PL,si npn,PL,si npn,DP,si npn,PL npn,PL	*162 *165 *170 *175 *175	16000 300 1.5W 500 500	200 175 200 200 200	91.43 2 3.42 2.85 2.85	80 *40 45 60 80	1000 40 30 50 50	2.23 *600 *240 *30 *30	- .5 0.001 .005 .005	*25 11 *5 *6 *6	- 18 5 18 18	SPR, GI, AL, UC, MO TR TR
HF 47	2N759B 2N2207 2N2459 2N2463 2N2512	SSD AMP SSD SSD	npn,PL pnp,AD,ge npn,PL npn,PL pnp,AD,ge	*175 175 *175 *175 *175	500 260 400 500 260	200 75 200 200 75	2.85 0.25 2.3 2.85 0.25	60 *70 60 60 *70	50 50 50 50 50	*25 200 *20 *20 *20 200	.005 - .002 .002 5	*6 - *6 *6 -	18 7 46 18 33	AMP
	2N2515 2N2518 2N2519 2N2521 2N2605	SSD SSD SSD SSD SSD	npn,PL npn,PL npn,PL npn,PL pnp,PL	*175 *175 *175 *175 *175 *175	400 400 400 400 400 400	200 200 200 200 200 200	2.3 2.3 2.3 2.3 2.3 2.3	60 80 80 60 45	50 50 50 50 50	*30 *30 *60 *25 *150	.005 .005 .005 .005 .010	*6 *6 *6 *6 *6	46 46 46 46 46	TI, AL, UC
HF 48	2N3244 2N3253 2N1493 2N2494 2N2495	MO MO RCA AMP AMP	pnp,ED,si npn,AE,si npn,si pnp,AD,ge pnp,AD,ge	*175 *175 *180 180 180	5W 5W 3W 100 100	200 200 175 85 85	28.6 28.6 20 1.67 1.67	40 *40 *100 *35 *35	1A - 50 10 10	*50-150 *25-75 15-200 70 70	.050 .5 10 2	*25 *12 *5 -	5 5 39 7 33	TI NA
	2N2496 2N3074 2N3762 2N3764 2N588	AMP AMP MO MO *SPR	pnp,AD,ge pnp,PADT,ge pnp,AE,si pnp,AE,si pnp,MD,ge	180 180 *180 *180 200	100 140 4000 2000 30	85 90 200 200 85	1.67 3.1 22.8 11.4 0.75	*35 25 40 40 *15	10 20 1500 1500 50	70 *14 *30 - 120 *30 - 120	2 10 - - 3	- 3 *15 *15 -	18 12 5 46 1	Icex=0.1 Icex=0.1 *PH ong Reg, GI
HF 49	2N706/51 2N706A/51 2N706B/46 2N706B/51 2N706C/46	SY SY SY SY SY	npn,si npn,si npn,PE,si npn,si npn,si	200 200 *200 200 200 200	300 300 400 300 400	200 200 200 200 200 200	- - - -	15 *25 *25 *25 *25 15	50 50 50 50 50	*20-60 *20-60 *20-60 *20-60 *20-60	.025 0.5 0.5 0.5 .025	5 5 5 5 5	51 51 46 51 46	TR TR GI, TR, NA TR GI, TR

						M	AX. RATI	NGS		CHARA	CTERIST	ICS		
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (MHz)	P c (m₩)	T _j (°C)	mW/°C	*VCEO *VCBO (V)	1 (mA)	hfe *h	¹ CO *1CEO †1CEX (μA)	C _{oe} *C _{ob} (pF)	Package Outline (TO-)	Remarks
HF 50	2N706C/51 2N736B 2N740A 2N752 2N760B	SY SSD SSD NA SSD	npn,si npn,PL npn,PL npn,DM,si npn,PL	200 *200 *200 *200 *200 *200	300 500 500 500 500 500	200 200 200 200 200 200	- 2.85 2.85 2.5 2.85	15 60 80 45 60	50 50 50 100 50	*20-60 *60 *60 40-120 *50	.025 .005 .005 0.1 .005	5 *6 6 5 *6	51 18 18 18 18	TR TR TR
HT 30	2N783 2N869 2N1962 2N1963 2N2397	SY FA SY SY SY	npn,EP,si pnp,DP,si npn,PE,si npn,PE,si npn,PE,si	200 *200 200 *200 *200	300 1.2W 400 400 300	100 200 175 175 200	- 6.86 - - -	*40 18 *40 *30 *35	200 - 200 200 200 200	*20-80 *60 *20-80 *25 *25-120	.025 0.005 0.25 0.25 0.1	3.5 *60 3.0 3.5 5	18 18 46 46 51	FA MO
HF 51	2N2401 2N2460 2N2464 2N2516 2N2522	*SPR SSD SSD SSD SSD SSD	pnp,MD,ge npn,PL npn,PL npn,PL npn,PL npn,PL	*200 *200 *200 *200 *200 *200	150 400 500 400 400	100 200 200 200 200 200	2.0 2.3 2.85 2.3 2.3	*15 60 60 60 60	100 50 50 50 50 50	*50 *35 *35 *60 *50	1.5 .002 .002 .005 .005	4 *6 *6 *6 *6	18 46 18 46 46	*PH orig Reg
HF 31	2N2618 2N2618/4 2N2876 2N2904 2N2904A	SY SY RCA MO MO	npn,PE,si npn,PE,si npn,si pnp,AE,si pnp,AE,si	*200 *200 *200 *200 *200 *200	600 400 17500 3W 3W	175 175 200 200 200	- 100 17.2 17.2	*60 *60 60 40 60	750 750 2500 600 600	*50-200 *50-200 50-275 *40-120 *40-120	.25 .25 0.1 .02	14 14 *20 *8 *8	5 5 - 5 5	TRWS TI, VEC GI, TR, SPR, AL GI, TR, SPR, AL
HF 52	2N2905 2N2905A 2N2906 2N2906A 2N2907	MO MO MO MO MO	pnp,AE,si pnp,AE,si pnp,AE,si pnp,AE,si pnp,AE,si	*200 *200 *200 *200 *200 *200	3W 3W 1.8W 1.8W 1.8W	*100 200 *100 200 200 200	200 17.2 10.3 10.3 10.3	40 60 40 60 40	600 600 600 600 600	100-300 100-300 40-120 *40-120 *100-300	.02 .01 .02 0.01	*8 *8 *8 *8	5 5 18 18 18	GI, TR, SPR, AL GI, TR, SPR, AL TR, SPR, AL GI, TR, SPR, AL GI, TR, SPR, AL
HF 32	2N2907A 2N2951 2N2952 2N3133 2N3134	MO MO MO MO MO	pnp,AE,si npn,EP,si npn,EP,si pnp,AE,si pnp,AE,si	*200 *200 *200 *200 *200 *200	1.8W 3W 1.8W 3W 3W	200 175 175 200 200	10.3 20 12 17.3 17.3	60 *60 *60 35 35	600 250 250 600 600	*100-300 *20/150 *20/150 *40-120 *100-300	.01 0.1 .1 .05	*8 *8 *8 *10 *10	18 5 18 5	GI, TR, SPR, AL TRWS, SPR TRWS SPR SPR
115.53	2N3135 2N3136 2N3229 2N3252 2N3298	MO MO RCA MO MO	pnp,AE,si pnp,AE,si npn,si npn AE,si npn,E,si	*200 *200 *200 *200 *200 *200	1.8W 1.8W 17.5W 5W 1W	200 200 200 200 200 175	10.3 10.3 100 28.6 6.67	35 35 60 *30 *25	600 600 2.5A - 100	*40-120 *100-300 - *30-90 *60-120	0.05 .05 0.1 .5 0.5	*10 *10 *20 *12 *6	18 18 60 5 18	SPR SPR 15W (min.)@50MHz NA TRWS
HF 53	2N3323 2N3324 2N3325 2N3426 2N3619	MO MO MO FA BE	pnp,EA,ge pnp,EM,ge pnp,EM,ge npn,PE,si npn,PE,si	*200 *200 *200 *200 *200 *200	300 300 300 3W 7.5W	100 100 100 200 175	4 4 4 17.2 50	*35 *35 *35 12 *75	100 100 100 1A 2.5A	*30-200 *30-200 *30-200 *50 *40	10 10 10 1.5 25	*3 *3 *6.2 *50	18 18 18 - 5	
115.54	2N3621 2N3622 2N3620 2N3623 2N3624	BE BE BE BE BE	npn,PE,si npn,PE,si npn,PE,si npn,PE,si npn,PE,si	200 200 200 200 200 200	15W 15W 7.5W 7.5W 7.5W	175 175 175 175 175 175	200 200 50 50 50	*75 *75 *75 *75 *75	5A 10A 5A 25 5A	*40 *40 *40 *40 *40	25 25 25 1	*50 *50 *50 *50 *50	61 61 † 5	Isolated Collector +MT-27 +MT-27
HF 54	2N3625 2N3626 2N3627 2N3628 2N3629	BE BE BE BE BE	npn,PE,si npn,PE,si npn,PE,si npn,PE,si npn,PE,si	200 200 200 200 200 200	15W 15W 7.5W 7.5W 20W	175 175 175 175 175 175	200 200 50 50 200	*75 *75 *100 *100 *100	5A 10A 2.5A 5A 10A	*40 *40 *40 *40 *40	25 1 1 1 1	*50 *50 *50 *50 *50	61 61 5 †	Isolated Collector + MT-27 Isolated collector
UF 55	2N3630 2N3691 2N3692 2N3693 2N3694	BE FA FA FA	npn,PE,si npn,PL,si npn,PL,si npn,DP,si npn,DP,si	200 *200 *200 200 200	20W 625 625 500 500	175 150 150 125 125	200 2 2 5 5	*100 *35 *35 45 45	10A 50 50 -	*40 *40-160 *100-400 *40 *100	1 .05 .05 5	*50 .5-3.5 .5-35 -	61 - - - -	R097A package, CDC R097A package, CDC R0110 package R0110 package
HF 55	2N3701 2N3766 2N4125 A415 A1590	FA FA MO AMP AMP	npn,DPE,si npn,DPE,si pnp,AE,si npn,PL,si npn,si	200 200 *200 *200 200	1.8 W 1.8 W 310 165 165	200 200 135 175 175	10.3 10.3 2.81 1.1 1.1	80 80 30 *50 *50	1000 1000 200 30 30	*120 *300 *50-150 *125 *125	10 10 .05 .010	- *4.5 -	18 18 92 72 72	Cre=0.55 pf. Cre=0.55 pf.
HE EC	FT4017 FT4018 MPS706 MPS2923 MPS2924	FA FA MO MO MO	pnp,DPE,si pnp,DPE,si npn,EP,si npn,EP,si npn,EP,si	*200 *200 *200 *200 *200 *200	1.1 W 1.1 W 500 200 200	200 200 125 100 100	.0062 .0062 5 2.67 2.67	80 60 *25 25 25	200 200 - 100 100	*100-500 *100-600 *20 235-470 150-300	.010 .010 0.5 0.5 0.5	- *6 *12 *12	92 92 92 92	Dual pnp Dual pnp
HF 56	MPS2925 SFT445 TN-81 UD-3005 UD-3006	MO NUC SPR SPR SPR SPR	npn,EP,si npn,si npn, PE,si npn,PE,si pnp,PE,si	*200 *200 200 200 200	200 3 800 350 350	100 - 200 200 200 200	2.67 - 4.57 -	25 *80 20 *60 *60	100 - 800 600 600	90-180 *10 *50 *100-300 *100-300	0.5 1 0.1 0.010 0.010	*12 8 *8 *8 *8	92 5 5 85 85	npn Quad pnp Quad

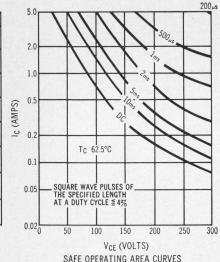
Who could build a better silicon power transistor than our DTS-423?

We could. Meet DTS-431.



PARAMETER	MAXIMUM	TYPICAL	MINIMUM
V _{CEO}	400V		
V _{CBO}	400V		
V _{CEO} (sus)		370	325
Ic	5A		
I _B	2.0A		
Junction Temperature	150° C		−65° C
h _{FE} (1 _C =2.5A V _{CE} =5V)	35		15
h _{fE} (I _C =3.5A V _{CE} =5V)			10

TYPICAL SWITCHING TIMES:
Rise time —0.40 Microseconds
Storage time—0.45 Microseconds
Fall time —0.35 Microseconds



Introducing the DTS-431, the newest addition to Delco Radio's line of high voltage silicon power transistors. It offers you a number of distinct design advantages over the DTS-423, including an even higher current capability.

What's more, the DTS-431 permits you to design with complete freedom within the rated specifications, for its safe operating data is not based on mere probability. Sustaining voltage (VCEO SUS) tests are performed on every DTS-431 we make. Not just a sample. Every one.

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ON READER-SERVICE CARD CIRCLE 15

						M	AX. RATI	NGS		CHARA	CTERISTI	CS	1-	
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (MHz)	P c (mW)	T _j (°C)	mW/°C	*VCEO CBO (V)	1 C (mA)	h _{fe}	lCO *lCEO †lCEX (μA)	C _{oe} *C _{ob} (pF)	Package Outline (TO-)	Remarks
HF 57	UD-3007 WS154 AF 106 2N2461 2N2465	SPR WH SA SSD SSD	npn, pnp, PE,si - pnp,MS,ge npn,PL npn,PL	200 *200 220 *225 *225	350 - 60 400 500	200 - 90 200 200	- 2.5 2.3 2.85	*60 - 18 60 60	600 - 10 50 50	*100-300 30 *50 *70 *70	0.010 - 0.5 .002 .002	*8 - *6 *6	85 - 18 46 18	Complementary Quad Quad
HF 37	2N996 2N499 2N499A 2N3588 2N929A	FA *SPR *SPR AMP SSD	pnp,PE,si pnp,MD,ge pnp,MD,ge pnp,PADT,ge npn,PL	*230 240 240 *240 *250	1.2W 30 60 100 500	200 85 100 75 200	6.85 0.75 0.8 2.2 2.85	12 *30 *30 *25 45	50 50 10 50	*75 8.5 50 *65 *60	0.0002 1 1 8 .002	*7.5 *1.3 *1.3 2 *6	18 1 1 18 18	TR *PH orig Reg, GI *PH orig Reg 4 lead AMP, TR, AL, UC
	2N947 2N957 2N1491 2N2217	FA FA RCA MO	npn,DP,si npn,DD,si npn,si npn,PE,si	*250 *250 *250 *250 *250	1200 800 3000 3W	200 150 175 175	6.9 6.5 20 20	*20 20 *30 30	100 - 50 -	*40 *60 15-200 *20-60	0.1 1 10 0.01	*7 *5 *5 8	18 18 39 5	TRWS, AMP GI, FA, SPR, TR, NA, TRWS, AMP, AL
HF 58	2N2218 2N2218A 2N3292 2N3293	MO MO MO	npn,PE,si npn,AE,si npn,E,si npn,E,si	*250 *250 *250 *250	3W 3W 300 300	175 175 200 200	20 20 1.71 1.71	30 40 *25 *20	- 50 50	*40-120 40-120 10-200 10-200	0.01 .01 0.1 0.1	8 *8 *2 *2	5 5 18 18	GI, FA, SPR, TR, NA, TRWS, AL, AMP SPR, TR, NA, AL AL AL
	2N3294 2N3326 2N3409 2N3410 2N3411	MO GI MO MO	npn,E,si npn,PE,si npn,si npn,PE,si npn,PE,si	*250 *250 250 250 250	300 800 600 600 600	200 175 200 200 200	1.71 5.33 3.4 3.4 3.4	*20 45 *60 *60 *60	50 800 500 500 500	10-200 *40-120 *30-120 *30-120 *30-120	0.1 0.01 0.01 0.01 0.01	*2 *8 *8 *8 *8	18 5 5 5 5	AL SPR SPR SPR
HF 59	2N3502 2N2219 2N2220	FA MO MO	pnp,PE,si npn,PE,si npn,PE,si	*250 *250 *250	3W 3W	200 175 175	17.2 20	60 30 30	600 -	*70 *100-300 *20-60	0.00005 0.01 0.01	4.5 8 8	5 5 18	TI GI, FA, SPR, TR, NA, TRWS, AL, AMP GI, FA, SPR, TR, NA, TRWS, AMP, AL
	2N2221 2N2221A 2N2222	MO MO MO	npn,AE,si npn,AE,si npn,AE,si	*250 *250 *250	1.8W 1.8W 1.8W	175 175 175	12 12 12	30 40 30		*40-120 40-120 *100-300	0.01 .01 0.01	8 *8 8	18 18 18	GI, FA, SPR, TR, NA, TRWS, AMP, AL GI, SPR, TR, NA, AL TRWS, GI, FA, SPR, TR, NA, AL, AMP
HF 60	2N2273 2N2402 2N2462 2N2466 2N2476	MO *SPR SSD SSD RCA	pnp,EM,ge pnp,MD,ge npn,PL npn,PL npn,PE,si	*250 *250 *250 *250 250	150 150 400 500 2W	100 100 200 200 200	2 2 2.3 2.85 3.4	15 *18 60 60 *60	100 100 50 50	*20-75 *60 *100 *100 *20	10 1.5 .002 .002 0.2	*3.5 *4 *6 *6	18 18 46 18 5	*PH orig Reg SPR
	2N2477 2N2523 2N2537 2N2537 2N2538 2N2539	RCA SSD MO MO MO	npn,PE,si npn,PL npn,AE,si npn,AE,si npn,AE,si	250 *250 *250 *250 *250 *250	2W 400 3W 3W 1.8W	200 200 200 200 200 200	3.4 2.3 17.2 17.2 10.3	*60 45 30 30 30	.50	*40 *40 *50-150 *100-300 *501.50	0.2 .002 .25 .25 .25	10 *6 *8 *8 *8	5 46 5 5	SPR GI, NA, SPR GI, NA, SPR GI, NA, SPR
HF 61	2N2540 2N2787 2N2788 2N2789 2N2790	MO GI GI GI	npn,AE,si npn,PE,si npn,PE,si npn,PE,si npn,PE,si	*250 *250 *250 *250 *250 *250	1.8W 3W 3W 3W 1.8W	200 300 300 300 300 300	10.3 5.33 5.33 5.33 3.33	30 *75 *75 *75 *75 *75	800 800 800 800 800	*100/300 *20 - 60 *40-120 *100-300 *20-60	.25 0.01 0.01 0.01 0.01	*8 *8 *8 *8	18 5 5 5 18	GI, NA, SPR SPR SPR SPR SPR SPR
	2N2791 2N2792 2N2958 2N2959 2N3015	GI GI MO MO FA	npn,PE,si npn,PE,si npn,AE,si npn,AE,si npn,PE,si	*250 *250 *250 *250 *250 *250	1.8W 1.8W 3W 3W 3W	300 300 175 175 200	3.33 3.33 20 20	*75 *75 20 20 *60	800 800 600 600	*40-120 *100-300 *40-120 *100-300 *10	0.01 0.01 .025 .025	*8 *8 *8 *8	18 18 5 5 5	SPR SPR GI, SPR, TRWS GI, SPR, TRWS SPR
HF 62	2N3115 2N3116 2N3118 2N3119 2N3248	MO MO RCA RCA MO	npn,AE,si npn,AE,si npn,si npn,si pnp,ED,si	*250 *250 *250 *250 *250 *250	1.8W 1.8W 4000 4000 1.2W	175 175 200 200 200	12 12 22.9 22.9 6.9	20 20 60 80 12	600 600 500 500	*40-120 *100-300 *50-275 *50-200 *50-150	.025 .025 .1 50 0.05	*8 *8 *6 *6 *8	18 18 5 5 18	GI, SPR, TRWS GI, SPR, TRWS
UE C2	2N3250 2N3283 2N3284 2N3285 2N3286	MO MO MO MO	pnp,ED,si pnp,EM,ge pnp,EM,ge pnp,EM,ge pnp,EA,ge	*250 *250 *250 *250 *250 *250	1.2W 100 100 100 100	200 100 100 100 100	6.9 1.33 1.33 1.33 1.33	*40 *25 *25 *20 *20	200 50 50 50 50 50	*50-150 *10-200 10-200 5-200 5-200	.02 10 10 10 10	*6 *1.5 *1.5 *1.5 *1.5	18 18 18 18 18	
HF 63	2N3291 2N3503 2N3504 2N3505 2N2656	MO FA FA FA TRWS	npn,E, si pnp,PE,si pnp,PE,si pnp,PE,si npn,PL,si	*250 *250 *250 *250 *250 *>250	300 3W 1.3W 1.3W 1200	200 200 200 200 200 200	1.71 17.2 2.28 2.28 6.86	*25 60 45 45 *25	50 600 600 600 200	10-200 *70 *70 *70 *70 160	0.1 0.00007 0.00005 0.00005 0.5	*2 4.5 *4.5 *4.5 *5	18 5 18 18 18	AL TI TI TI KSC

						MA	X. RATI	NGS		CHARA	CTERISTI	CS		
Cross Index Key	Type No.	Mfr.	Туре	fae *f _T (MHz)	P c (mW)	T _j (°C)	mW/°C	*VCEO *VCBO (V)	C (mA)	h _{fe} *h	¹ C0 * ¹ CE0 † ¹ CEX (μA)	C _{oe} *C _{ob} (pF)	Package Outline (TO-)	Remarks
HF 64	2N3734 2N3735 2N3736 2N3737 2N3903	MO MO MO MO MO	npn,AE,si npn,AE,si npn,AE,si npn,AE,si npn,AE,si	*250 *250 *250 *250 *250	4000 4000 2000 2000 310	200 200 200 200 200 135	22.8 22.8 11.4 11.4 2.81	30 50 30 50 40	1500 1500 1500 1500 200	*30-120 *20-80 *30-120 *20-80 *50-150	†0.2 †0.2 †0.2 †0.2 †0.2 †.05	*9 *9 *9 *9	5 5 46 46 92	
NF 04	2N3905 2N3946 2N4123 2N4126 2N930A	MO MO MO MO SSD	pnp,AE,si npn,AE,si npn,AE,si pnp,AE,si npn,PL	*250 *250 *250 *250 *250 *275	310 1200 310 310 500	135 200 135 135 200	2.81 6.9 2.81 2.81 2.85	40 40 30 25 45	200 200 200 200 200 50	*50-150 *50-150 *50-150 *120-360 *150	†.05 †.01 .05 .05 .002	*4.5 *4 *4 *4.5 *6	92 18 92 92 18	AMP, AL
	2N1492 2N2524 AF 109 FT4019 2N784	RCA SSD SA FA SY	npn,si npn,PL pnp,MS,ge pnp,DPE,si npn,EP,si	*275 *275 280 *280 300	3000 400 60 1.1 W 300	175 200 90 200 175	20 2.3 2.5 .0062	*60 45 18 45 *30	50 50 12 200 200	15-200 *100 *100 *250-600 *25-150	10 .002 1.0 .010 .25	*5 *6 - - 3.5	39 46 18 - 18	agc pre-stages Dual pnp FA
HF 65	2N784/51 2N784A 2N835 2N835/46 2N835/51	SY SY MO SY SY	npn,EP,si npn,EP,si npn,EP,si npn,PE,si npn,PE,si	300 300 *300 *300 *300	300 360 1W 400 300	175 200 175 200 200	- - 6.67 - -	*30 *40 *25 *25 *25	200 200 200 200 200 200	*25-150 *25-150 201- *20 *20	.025 .025 0.5 0.5 0.5	3.5 3.5 4 *4 *4	51 18 18 46 51	SY, GE, GI, ITT, SPR GI
	2N914/46 2N914/51 2N915 2N963 2N967	SY SY FA MO MO	npn,PE,si npn,PE,si npn,DP,si pnp,EM,ge pnp,EM,ge	*300 *300 *300 *300 *300	400 300 1200 300 300	200 200 200 100 100	- 6.9 4 4	*40 *40 50 *12 *12		*30-120 *30-120 *100 *20/- 40/-	.025 .025 0.005 5	*6 6 *3 *5 *5	46 51 18 18 18	GI AMP, NA, AL SY, TI, RCA SY, TI, RCA
HF 66	2N988 2N989 2N1493 2N2219A 2N2222A	TRWS TRWS RCA MO MO	npn,PL,si npn,PL,si npn,si npn,PE,si npn,AE,si	*300 *300 *300 *300 *300	1000 1000 3000 3W 1.8W	175 175 175 175 175 175	6.67 6.67 20 20 12	*20 *20 *100 40 40	220 220 50 800	*20-120 *20-120 15-200 100-300 *100-300	0.5 0.5 10 0.01 .01	*4 *3.5 *5 *8 *8	18 18 39 5 18	CT TR, SPR, TRWS GI, SPR, TR, NA, TRWS
	2N2318 2N2319 2N2320 2N2381 2N2382	GI GI GI MO MO	npn,si npn,si npn,si pnp,EM,ge pnp,EM,ge	*300 *300 *300 *300 *300	360 300 600 750 750	175 175 175 175 100 100	2.0 1.7 3.4 10 10	15 15 15 15 20	- - 500 500	*40 *40 *40 *40 *40	.050 .050 .050 1	*5 *5 *5 *3.5 *3.5	18 46 5 5	STC STC STC
HF 67	2N2489 2N2795 2N2796 2N2885 2N2887	SPR SPR SPR TR TRWS	pnp,ED,ge pnp,ED,ge pnp,ED,ge npn,PL,si npn,PL,si	*300 *300 *300 300 *300	60 75 75 150 25000	100 100 100 175 200	0.8 1 1 1 142.8	*20 *25 *20 15 80	100 100 100 50 1200	*20 *100 *60 *30-120 *15-80	2.5 - - .025 -	3 *2.5 *2.5 *6 *30	18 18 18 51	
HF 68	2N3043 2N3249 2N3251 2N3281 2N3282	SPR MO MO MO MO	npn,PE,si pnp,AE,si pnp,AE,si pnp,EM,ge pnp,EM,ge	*300 *300 *300 *300 *300	1.4W 1.2W 1.2W 100 100	200 200 200 100 100	9.33 6.9 6.9 1.33 1.33	45 12 *50 15 15	30 - 200 50 50	*100-300 *100-300 *100-300 *10-100 *10-100	0.01 - - 5 5	*8 *8 *6 *1.2 *1.2	18 18 18 18	Flat Pack
HF 00	2N3289 2N3290 2N3307 2N3308 2N3309	MO MO MO MO	npn,E,si npn,E,si pnp,EA,si npn,EA,si npn,E,si	*300 *300 *300 *300 *300	300 300 300 300 3.5W	200 200 200 200 200 175	1.71 1.71 1.71 1.71 23.3	15 15 35 25 *50	50 50 50 50 50 50	*10-200 *10-200 *40-250 *25-250 *5-100	0.010 0.010 0.010 0.010 0.5	*1.5 *1.5 *1.3 *1.3 *10	18 18 18 18 18	AL AL
	2N3854 2N3854A 2N3904 2N3906 2N3947	GE GE MO MO	npn,PE,si npn,PEP,si npn,AE,si pnp,AE,si npn,AE,si	*300 *300 *300 *300 *300	200 200 310 310 1200	100 100 135 135 200	2.67 2.67 2.81 2.81 6.9	18 30 40 40 40	100 100 200 200 200	*35-70 *35-70 *100-300 *100-300 *100-300	0.5 0.5 *.05 *.05 *.01	*2.5 *2.5 *4 *4.5 *4	98 98 92 92 18	
HF 69	2N4124 2N4264 2N4265 40292 A467	MO MO MO RCA AMP	npn,AE,si npn,AE,si npn,AE,si npn,si npn,PL,si	*300 *300 *300 *300 *300	310 310 310 23.2W 150	135 135 135 200 175	2.81 2.81 2.81 132 1.0	25 15 12 - *40	200 200 200 1.25A 25	*120-360 *40 - 160 *100 - 400 - *60	.05 †0.1 †0.1 *250 .001	*4 *4 *4 *30	92 92 92 60 72	Vces=90; overlay type Cre=.015 pf
	ED-322 MM709 T1408 T1409 2N503	SPR MO TI TI *SPR	pnp,ge npn,AE,si npn,PL,si npn,PL,si pnp,MD,ge	*300 *300 *300 *300 320	75 750 200 200 25	100 200 125 125 85	1.0 4.3 2 2 0.5	15 8 12 12 *20	100 100 30 30 50	*50 *15-120 *15 *15 *15 4.2	- .015 0.5 0.5 3	*3 *3 2.2 2.2 2	18 52 - - 9	Hi Rel 2N2795 Plast IEC, GME Plast IEC, GME *PH orig. Reg.
HF 70	2N779A 2N846A 2N968 2N969 2N970	*SPR *SPR MO MO	pnp,MD,ge pnp,MD,ge pnp,MD,ge pnp,MD,ge pnp,MD,ge	*320 *320 *320 *320 *320	60 60 300 300 300	100 100 100 100 100	0.8 0.8 4 4	*15 *15 *15 *12 *12	100 100 - - -	*90 *50 *35 *35 *35	1.0 1.0 3 3 3	*1.9 *1.9 *4 *4 *4	18 18 18 18	*PH orig Reg *PH, orig, Reg SY, TI TI TI

						M	AX. RATI	NGS		CHAR	ACTERIST	ICS		
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (MHz)	P c (m₩)	T _j (°C)	mW/°C	V CEO *V CBO (V)	I _C (mA)	h _{fe} *h	ICO *ICEO †ICEX (µA)	C _{oe} *C _{ob} (pF)	Package Outline (TO-)	Remarks
UE 71	2N971 2N972 2N973 2N974 2N975	MO MO MO MO MO	pnp,MD,ge pnp,MD,ge pnp,MD,ge pnp,MD,ge pnp,MD,ge	*320 *320 *320 *320 *320	300 300 300 300 300 300	100 100 100 100 100	4 4 4 4	*7 *15 *12 *12 *7		*35 *75 *75 *75 *75	10 3 3 3 10	*4 *4 *4 *4 *4	18 18 18 18 18	TI TI TI TI
HF 71	2N2256 2N2257 2N2258 2N2259 2N834/46	MO MO MO MO SY	npn,ME,si npn,ME,si pnp,ME,ge pnp,ME,ge npn,EP,si	*320 *320 *320 *320 *350	1000 1000 300 300 400	175 175 100 100 200	6.67 6.67 4 4	7 7 7 7 *40	100 100 100 100 200	*30 *50 *30 *50 *25	3 3 3 0.5	*4 *4 *4 4	18 18 18 18 46	CL CL GI, NA
	2N834/51 2N914	SY FA	npn,EP,si npn,PE,si	*350 *350	300 1.2W	200 200	6.9	*40 15	200	*25 *55	0.5 0.004	4 *4.5	51 18	SY, MP, TR, GI, AMP, SPR, NUC,
	2N984 2N2170	SPR SPR	pnp,MD,ge pnp,MD,ge	*350 *350	60 60	100 100	0.8	*15 *15	100 100	*70 *70	1	*1.9 *1.9	18 9	MU
HF 72	2N2501 2N2845 2N2846 2N2847 2N2848	MO FA FA FA FA	npn,AE,si npn,PE,si npn,PE,si npn,PE,si npn,PE,si	*350 *350 *350 *350 *350	1.2W 1.2W 3W 1.2W 3W	200 200 200 200 200 200	6.9 6.9 17.2 6.9 17.2	20 30 30 20 20	11111	*50-150 *60 *60 *60 *60	- 0.04 0.04 0.04 0.04	*4 *6 *6 *6 *6	18 18 5 18 5	SY, GI, TR, SPR SPR, NA SPR, NA SPR, NA SPR, NA, RCA, NUC
	2N2894 2N2955 2N3009	FA MO FA	pnp,PE,si pnp,EM,ge npn,PE,si	*350 *350 *350	1.2W 300 1200	200 100 200	6.85 4 6.85	12 *40 *40	- 100 200	*75 *20/60 *15	5 - -	*3.3 *2.5 *5	18 18 52	π
HF 73	2N3287 2N3288 2N3855 2N3855A 40282	MO MO GE GE RCA	npn,E,si npn,E,si npn,PE,si npn,PEP,si npn,si	*350 *350 *350 *350 *350	300 300 200 200 23,2W	200 200 100 100 200	1.71 1.71 2.67 2.67 015	20 20 18 30 18	50 50 100 100 2a	*15-150 *15-150 *60-120 *60-120	0.010 0.010 0.5 0.5 * 250	*1.1 *1.5 *2.5 *2.5 *45	18 18 98 98 98	
	MPS834 2N741 2N741A 2N2487 2N2488	MO MO MO SPR SPR	npn,EP,si pnp,DM,ge pnp,DM,ge pnp,ED,ge pnp,ED,ge	*350 *360 *360 *360 *360	500 300 300 60 60	125 100 100 100 100	5 2 2 0.8 0.8	30 *15 *20 *15 *15	200 100 100 100 100	*25 *25 *25 *20 *20	0.5 .2 .2 .2 3	*4 *6 *6 *3 3	92 18 18 18 18	SY, TI SY, TI
HF 74	2N2956 2N3856A 2N3856 2N706 2N706B	MO GE GE FA MO	pnp,EM,ge npn,PEP,si npn,PE,si npn,DD,si npn,EP,si	*375 *375 *375 *400 *400	300 200 200 1.0W 1W	100 100 100 175 175	4 2.67 2.67 6.7 6-7	*40 30 18 *25 *25	100 100 100 -	*40-120 *100-200 *100-200 *45 *20-60	10 0.5 0.5 0.005 0.005	*2.5 *2.5 *2.5 *5 *5	18 98 98 18 18	SY, MO, TR, GI, AMP, SPR, ITT FA, SY, GI, TR, ITT
	2N706 C 2N707 2N708 2N828 2N828A	FA FA MO MO	npn,DD,si npn,DD,si npn,DP,si pnp,EM,ge pnp,EM,ge	*400 400 *400 *400 *400	1,2W 1,0W 1,2W 300 300	200 175 200 100 100	6.9 6.7 6.9 .4 4	15 *56 15 *15 *15	50 - - 200 200	*40 *12 *50 40 *40	0.010 0.005 0.004 .4 0.4	*4 *5 *4 *3.5 *2.2	18 18 18 18 18	GI, TR TRWS, MO, GI FA, SY, MO, TR, GI, AMP, RCA SY, TI, RCA, LAN TI
HF 75	2N829 2N916 2N2096 2N2097 2N2099	MO FA	pnp,EM,ge npn,DP,si pnp,ED,ge pnp,ED,ge pnp,ED,ge	*400 *400 *400 *400 *400	300 1200 750 750 750	100 200 100 100 100	6.9 10 10	*15 25 *25 *40 *25	200 - 500 500 500	*80 *100 *40 *70 *40	0.4 0.005 6 6 6	*2.2 *5 *15 *15 *15	18 18 31 31 9	TI TRWS, AMP, NA, MO MO MO MO MO
	2N2100 2N2957 2N2996 2N2997 2N3279	MO TI TI MO	pnp, ED, ge pnp, EM, ge pnp, ge pnp, ge pnp, EM, ge	*400 *400 *400 *400 *400	750 300 75 75 100	100 100 100 100 100	10 4 1 1 1.33	*40 *40 *15 *30 20	500 100 50 50 50	*70 *100 35 50 *10-70	6 - 5 5 5	*15 *2.5 *3 *1.8 *1.0	9 18 72 72 72 18	МО
HF 76	2N3280 2N3299 2N3300 2N3301 2N3302	MO FA FA FA FA	pnp,EM,ge npn,PE,si npn,PE,si npn,PE,si npn,PE,si	*400 *400 *400 *400 *400	100 3W 3W 1.8W 1.8W	100 200 200 200 200 200	1.33 17.2 17.2 10.3 10.3	20 30 30 30 30 30	50 - - -	*10-70 *75 *220 *75 *220	5 0.0002 0.0002 0.0002 0.0002	*1.2 *6.0 *6.0 *6.0 *6.0	18 5 5 18 18	
U=	2N3327 2N3337 2N3338 2N3339 2N3371	NSC FA FA FA TI	npn npn,PE,si npn,PE,si npn,PE,si pnp,ge	400 *400 *400 *400 *400	20W 500 500 500 500 150	200 200 200 200 200 100	134 2.86 2.86 2.86 2	65 40 40 40 *25	2.0a - - - 100	*10 *30 *30 *30 25-500	500mA 0.025 0.025 0.025 7	*30 *1.6 *1.6 *1.6 *4	60 - - - 18	
HF 77	2N3632 2N3688 2N3689	RCA FA FA	npn,si npn,PL,si npn,PL,si	*400 *400 400	23W 500 500	200 125 125	130 5 5	40 40 40	3A 4 4	30-70 30-70	250 5 5	*20 1.1 1.1	60	RCA "Overlay" emitter type, MO, VEC R0110 package R0110 package
	2N3690	FA	npn,PL,si	400	500	125	5	40	4	30-70	5	1.1	-	R0110 package

GENERAL INSTRUMENT SEMICONDUCTORS

CONDENSED CATALOG/1966



INTRODUCTION

From the simplest diode . . .

to the most complex Microelectronics array

... That, in a few words, is an apt description of General Instrument's Semiconductor line. But it is by no means complete, because this line is characterized by several far-reaching technical developments which have had a profound effect on many segments of the electronic industry.

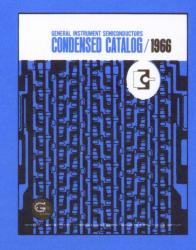
Two such developments are depicted on the cover of this publication: The enormously complex MOS array, for example, represents previously unimagined opportunity for the computer manufacturer. The idea of an entire computer on a single 80-by 58 mil chip is already entirely feasible. You'll find MOS arrays and field effect transistors listed on Page 4.

And, at the other end of the semiconductor spectrum, the simple diode has undergone an amazing evolution. The recent General Instrument announcement of the HERCULEADST.M. Beam-Lead Diode (listed on Page 10) has ushered in a new era in processing discrete semiconductors.

No bigger in its entirety than a typewriter period (it takes 4 million to make a pound), the HERCULEADS diode is practically indestructible — it can withstand impact shocks of 200,000 G's; is immune to the metallurgical "diseases" that plague conventional devices; and is completely "passivated" in the production process, so that it needs no hermetically sealed container to protect it from environmental effects.

These are just two of many technical achievements you'll find incorporated in General Instrument's semiconductor line. Glass-Amp® Rectifiers and Zener Diodes; Hybrid Micro-circuits; a new line of low-cost epoxypackaged silicon transistors — they're all listed on the following pages in an easy-to-use format. Also, you'll find the numerical index beginning on Page 22 an additional convenience.

And it goes without saying, of course, that service from any of the General Instrument sales offices or authorized distributors throughout the country is no further away than your telephone.



CONTENTS



SECTION		PAGE
1	INTRODUCTION	2
2	PRODUCTS MOS SEMICONDUCTORS MOS MICROCIRCUIT ARRAYS MOS FIELD EFFECT TRANSISTORS HYBRID MICROCIRCUITS HIGH SPEED DIGITAL MICROCIRCUITS MULTICHIP ANALOG CIRCUITS SILICON RECTIFIERS Glass-Amp® SILICON RECTIFIERS SILICON RECTIFIERS & DIODES SILICON DIODES HERCULEADS™ BEAM-LEAD DIODES ZENER VOLTAGE REGULATOR DIODES GERMANIUM TRANSISTORS SILICON TRANSISTORS EPOXY ENCAPSULATED SILICON TRANSISTORS GERMANIUM DIODES SOLID STATE ASSEMBLIES SELENIUM RECTIFIER ASSEMBLIES	4 4 5 5 6 7 8 9 10 11 13 14 15 16 18 20
3	NUMERICAL INDEX	22
4	CASE DRAWINGS	24
	SALES OFFICES	

AND AUTHORIZED

DISTRIBUTORS

5

26

MOS SEMICONDUCTORS

MOS MICROCIRCUIT ARRAYS (Ta = -55°C to +85°C)

ТҮРЕ	FUNCTION	CASE	FUNCTION DIAGRAM FIG. NO.	POWER CONSUMPTION (mW)	SUPPLY VOLTAGE (VOLTS)	SHIFT PULSE FREQUENCY (kHz)	INPUT CAPACITANCE (pf)	OUTPUT IMPEDANCE (KΩ)
SHIFT REGI	STER, FLIP-FLOP CIRCU	JITS						
¹ MEM 3021 ² MEM 3020 ³ MEM 1005	21-Bit dc, 1φ clock 20-Bit Dynamic, 2φ clock RST Flip-Flop	1 1 1	1 2 3	<200 <200 < 80	28 ±5% 26 ±5% 28 ±5%	dc to 500 dc to 1 Mc dc to 1 Mc	2 2 2	<2 <2 { 2 @ "0" { 10 @ "1"

¹ Formerly MEM 501. ² Formerly MEM 521. ³ Formerly MEM 529.

LOGIC CIRC	cuits					PROPAGATION DELAY (nsec)	CAPACITANCE (pf)	FREQUENCY (kHz)
¹ MEM1002	Dual 3-Input NOR-Gate	1	4	30	-26 ±5%	500	3.0	dc to 500
MEM 1000	Dual Full Adder	7	5	25	-12 & 26 ±5%	500	3.0	dc to 500

¹ Formerly MEM 522.

SERIES SH	UNT CHOPPER		OFFSET VOLTAGE	CLOCK ϕ	FRE- QUENCY (kHz)	SERIES SHUNT RESISTANCE RESISTANCE RATIO (TYP)	ON RESISTANCE PER UNIT (SERIES OR SHUNT) (Ω TYP)	OFF RESISTANCE PER UNIT (SERIES OR SHUNT) (Ω TYP)	SIGNAL VOLTAGE HANDLING RANGE (TYP)
¹MEM 2008	Integrated Series Shunt Chopper Circuit (See Fig. 6)	4	0	1	100	200 DB	6x10 ⁺³	1013	1μV up to 10V

¹ Formerly MEM 590.

MULTIPLEX	ER CIRCUITS	CASE	OFF RESISTANCE (Ω TYP)	ON RESISTANCE (Ω TYP)	CAPACITANCE (pf) Cgd	BVDSS (VOLTS)	BVGSS (VOLTS)
MEM 2001 MEM 2002 MEM 2003 MEM 2004	See circuit diagram No. 7 See circuit diagram No. 8 See circuit diagram No. 9 See circuit diagram No. 9	7 7 8 8	10 ¹¹ 10 ¹¹ 10 ¹¹ 10 ¹¹	500 500 500 250	1.1 1.1 1.1 1.5	—30 —30 —30 —30	25 25 25 ±40
MEM 2004A MEM 2005 MEM 2006 MEM 2007	See circuit diagram No. 9 See circuit diagram No. 10 See circuit diagram No. 11 See circuit diagram No. 11	8 7 8 8	10 ¹¹ 10 ¹¹ 10 ¹¹	250 500 500 250	1.5 1.1 1.1 1.5	30 30 30 30	—25 —25 —25 —25

¹MEM 2001 thru MEM 2007 formerly MEM 5001 thru MEM 5007

MOS SILICON P-CHANNEL ENHANCEMENT MODE FIELD EFFECT TRANSISTORS (TA = 25°C, body grounded)

ТҮРЕ	CASE	VG (VOI MAX.		ID (ON) (mA TYP)	IDSS (nA TYP)	IGSS (nA TYP)	BVDSS (VOLTS)	BVGSS (VOLTS)	Υ _{fs} (μmho TYP)	Cgd (pf TYP)	rds ON (Ω TYP)
MEM 511 MEM 517 MEM 517A MEM 517B	10 5 6 10	-3 -2.5 -2.5 -2.5	—6 —5 —5 —5	6 60 60	.2 .8 .8	.05 .05 .05	40 30 30 30	-30 -25 -25 -25	2500 12000 12000 12000	1.5 10 16 10	250 45 45 45
MEM 520 MEM 550 MEM 551	10 2 13	_3 _3 _3	—6 —6 —6	—6 —3 —3	.2 .2 .2	.001 .05 .001	30 30 30	±40 —25 ±40	2500 2500 2500	1.5 1.1 1.1	250 500 500

FUNCTION DIAGRAMS

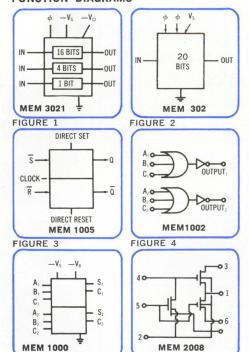
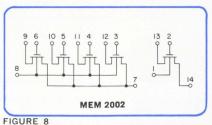
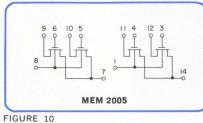


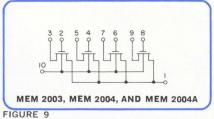
FIGURE 6







MEM 2001



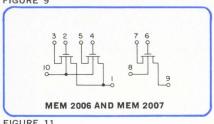


FIGURE 11

FIGURE 7

FIGURE 5

HYBRID MICROCIRCUITS

AMPLIFIERS

TYPE* (TA = 25°C)	FUNCTION	CASE	Voltage Gain (db)	Input Impedance (K ohms)	Input Offset Voltage (mV)	Offset Voltage Drift (µV/°C)	Common- Mode Rejection (db)	Input Broadband Noise (µVrms)	Band Width (KHz)	Supply Voltages (Vdc)	Temp. Range °C
NC/PC-101	NANOCIRCUIT VIDEO AMPLIFIER	22 & 23	20	1.2	-	-	-	10	20,000	+6	—55 to +125
PC-200	OPERATIONAL AMPLIFIER GENERAL PURPOSE	24	73	100	1	5	80	5	15	±12	—55 to +125
PC-201	OPERATIONAL AMPLIFIER HIGH COMMON — MODE REJECTION	25	73	200	1	5	100	5	15	±12	—55 to +125
PC-210	OPERATIONAL AMPLIFIER LOW NOISE, WIDE B.W., H.V.	32	70	90	3	4	80	4	1,500	±18	—55 to +125
PC-212	OPERATIONAL AMPLIFIER LOW NOISE, WIDE B.W.	32	64	100	3	4	80	4	1,200	±12	—55 to +125
PC-250	OPERATIONAL AMPLIFIER ULTRA-HIGH (MOS) INPUT IMPEDANCE	26	50	10 ¹⁴ (ohms)	50	500	42	-	30	±12	—55 to +85
PC-251	OPERATIONAL AMPLIFIER ULTRA-HIGH (MOS) INPUT IMPEDANCE SHORT CIRCUIT PROOF	26	50	10 ¹⁴ (ohms)	50	500	42	-	30	±12	—55 to +85

TYPE* (TA = 25°C)	FUNCTION	CASE	Output Voltage (Vdc)	Load Regulation %	Line Regulation %	Ripple Rejection μουτ/ μin	Output Impedance ohms	Temp. Coefficient mV/°C	Power Dissipation 25°C (mW)	Temp. Range °C
POWER SUI	PPLY VOLTAGE REGULA	TORS**								
PC-501 PC-503	12 V OVERLOAD PROTECTION	18 18	+12V 12V	.025 .025	0.5 0.5	.03	0.1 0.1	0.3 0.3	500 500	—55 to +125 —55 to +125
PC-502 PC-504	24 V OVERLOAD PROTECTION	18 18	+24V 24V	.05 .05	0.5 0.5	.06 .06	0.2 0.2	1.5 1.5	500 500	—55 to +125 —55 to +125
NC/PC-511 NC/PC-513	12 V GENERAL PURPOSE APPLICATION	19 & 20 19 & 20	+12V 12V	.025 .025	0.5 0.5	.03	0.1	0.3 0.3	500 500	—55 to +125 —55 to +125
PC-512 PC-514	24 V GENERAL PURPOSE APPLICATION	20 20	+24V 24V	.05 .05	0.5 0.5	.06 .06	0.2	1.5 1.5	500 500	—55 to +125 —55 to +125
PC-521 PC-523	6 V GENERAL PURPOSE APPLICATION	21 21	+6V 6V	.07 .07	0.4	.04 .04	.05 .05	0.3	500 500	—55 to +125 —55 to +125
†NCS-675A	†5 V GENERAL PURPOSE APPLICATION	14	+5V	.04	0.5	_	.005	5	500	—55 to +125

HIGH VOLTAGE ANALOG SWITCHES

TYPE (TA = 25°C)	FUNCTION	CASE	Turn On Time (nsec)	Turn Off Time (nsec)	Offset Voltage (mV)	Turn On Voltage (Volts)	Repetition Rate (KHz)	Maximum Supply Voltage (Volts)	Maximum Analog Voltage (Volts)	Overshoot Voltage (Volts)
PC-401	SINGLE INPUT	12	50	200	20	3	200	+50	+35	2.5
PC-402	COMPLEMENTARY INPUT	13	50	200	20	3	200	+50	+35	2.5

			TEMPERATUR	E RANGE 55	°C to +125°C	SUPPLY	CLAMP	MAXIMUM	
TYPE*	FUNCTION		PROPAGATION DELAY @ 25°C (nsec TYP)	POWER	FANOUT (EACH OUTPUT)	VOLTAGE (VOLTS) VCC	VOLTAGE (VOLTS) VCL	REPETITION RATE (MHz)	LOGIC LEVELS (VOLTS)
INARY CIR	CUITS								
NC-8, PC-8 NC-9, PC-9 PC-13	FLIP-FLOP STEERING GATE RST FLIP-FLOP	14 & 11 15 & 27 16	Ξ	200 200	3 NORS and/or 5 NANDS	+12V +12V +12V	+4.2V +4.2V +4.2V	20 20 20	+.3V, +5V +.3V, +5V +.3V, +5V
OR-GATES									
NC-10 PC-10 PC-14	SINGLE 4-INPUT SINGLE 6-INPUT DUAL 3-INPUT	17 16 16	8 8 8	170 170 170	4 NORS and/or 5 NANDS	+12V +12V +12V	+4.2V +4.2V +4.2V	12 12 12	+.3V, +5V +.3V, +5V +.3V, +5V
AND-GATES	S								
NC-11 PC-11 PC-15	SINGLE 4-INPUT SINGLE 6-INPUT DUAL 3-INPUT	17 16 16	8 8 8	60 60 60	4 NORS and/or 5 NANDS	+12V +12V +12V	+4.2V +4.2V +4.2V	15 15 15	+.3V, +5V +.3V, +5V +.3V, +5V
ELAY CIRC	CUITS								M. Balli
NC-16, PC-16 PC-18	SINGLE SHOT TRIGGERED SINGLE SHOT	14 & 29 30	=	200 200	3 NORS and/or 5 NANDS	+12V +12V	+4.2V +4.2V	10¹ 10¹	+.3V, +5V +.3V, +5V
RIGGER CI	IRCUITS								
NC-17, PC-17	SCHMITT TRIGGER	14 & 3	1 —	200	3 NORS and/or 5 NANDS	+12V	+4.2V	5	+.3V, +5V
BUFFER AM	IPLIFIER								
NC-12, PC-12	NON-INVERTING AMPLIFIER	15 & 28	_	200	120 mA @ .3V 70 mA @ 5V²	+12V	+4.2V	12	+.3V, +5V

CUSTOM CIRCUITS: Complete facilities available to meet your special requirements.

^{*} PC prefix indicates flat packs; NC indicates TO-5 package. † Specified with external pass transistor with 3 amp load.

** These units are self-contained voltage regulators and with an external pass transistor can regulate leads up to 10 amperes.

FE: 1 60% maximum duty cycle. 2 With external 100 ohm resistor.

NOTE: 1 60% maximum duty cycle.

SILICON RECTIFIERS

TOP HAT TYPE RECTIFIERS

CASE 33

		RECTIFIED 1/2 WAVE, 60	AVERAGE CURRENT RES. LOAD Hz	OPERAT TEN RAN	IP.	STOR TEN RAN	MP.	MAXIMUM FORWARD PEAK SURGE CURRENT 1 ∼, 60 Hz SUPERIMPOSED	FOR VOI @ T	CIMUM EWARD LTAGE A 25°C	MAXII REVERSE @ R/ DC BLOCKIN @ 25°	CURRENT TED IG VOLTAGE
TYPE	PRV VOLTS	mA AAV	@ TA °C	MIN °C	MAX	MIN	MAX °C	APK	VF VDC	IF MADC	VR VDC	IR μ A DC
1N440	100	300	50	—55	150	—55	175	15	1.5	300	100	0.30
1N440B	100	750	50	—55	165	—55	175	15	1.5	750	100	0.30
1N441	200	300	50	—55	150	—55	175	15	1.5	300	200	0.75
1N441B	200	750	50	—55	165	—55	175	15	1.5	750	200	0.75
1N442	300	300	50	—55	150	—55	175	15	1.5	300	300	1.0
1N442B 1N443 1N443B 1N4444 1N444B	300 400 400 500 500	750 300 750 300 650	50 50 50 50 50	—55 —55 —55 —55 —55	165 150 165 150	—55 —55 —55 —55 —55	175 175 175 175 175	15 15 15 15 15	1.5 1.5 1.5 1.5 1.5	750 300 750 300 650	300 400 400 500 500	1.0 1.5 1.5 1.75 1.75
1N445	600	300	50	—55	150	—55	175	15	1.5	300	600	2.0
1N445B	600	650	50	—55	150	—55	175	15	1.5	650	600	2.0
1N530	100	300	100	—55	100	—55	180	1.5	2.0	300	100	3.0
1N531	200	300	100	—55	100	—55	180	1.5	2.0	300	200	7.5
1N532	300	300	100	—55	100	—55	180	1.5	2.0	300	300	10.0
1N533	400	300	100	—55	100	—55	180	1.5	2.0	300	400	15.0
1N534	500	300	100	—55	100	—55	180	1.5	2.0	300	500	17.5
1N535	600	300	100	—55	100	—55	180	1.5	2.0	300	600	20.0
1N536	50	250	150	—65	175	—65	200	15	1.1	500	50	10
1N537	100	250	150	—65	175	—65	200	15	1.1	500	100	10
-1N538 1N539 -1N540 -1N547 -1N560	200 300 400 600 800	250 250 250 250 500	150 150 150 150 100	—65 —65 —65 —65 —55	175 175 175 175 175	—65 —65 —65 —65	200 200 200 200 200 175	15 15 15 15 25	1.1 1.1 1.1 1.1 1.1	500 500 500 500 500	200 300 400 600 800	10 10 10 10 5
1N561	1000	500	100	—55	175	—65	175	25	1.1	500	1000	5
1N599	50	300	100	—55	150	—55	175	2	1.5	300	50	2.5
1N599A	50	300	100	—55	150	—55	175	2	1.5	300	50	1.0
1N600	100	300	100	—55	150	—55	175	2	1.5	300	100	2.5
1N600A	100	300	100	—55	150	—55	175	2	1.5	300	100	1.0
1N601	150	300	100	—55	150	—55	175	2	1.5	300	150	2.5
1N601A	150	300	100	—55	150	—55	175	2	1.5	300	150	1.0
1N602	200	300	100	—55	150	—55	175	2	1.5	300	200	2.5
1N602A	200	300	100	—55	150	—55	175	2	1.5	300	200	1.0
1N603	300	300	100	—55	150	—55	175	2	1.5	300	300	2.5
1N603A	300	300	100	—55	150	—55	175	2	1.5	300	300	1.0
1N604	400	300	100	—55	150	—55	175	2	1.5	300	400	2.5
1N604A	400	300	100	—55	150	—55	175	2	1.5	300	400	1.0
1N605	500	300	100	—55	150	—55	175	2	1.5	300	500	2.5
1N605A	500	300	100	—55	150	—55	175	2	1.5	300	500	1.0
1N606 1N606A 1N1095 1N1097 1N1100	600 600 500 600 100	300 300 250 250 250	100 100 135 130 150	—55 —55 —65 —65 —55	150 150 175 175 150	—55 —55 —65 —65 —55	175 175 200 200 180	2 2 15 15 15	1.5 1.5 1.1 1.1	300 300 500 500 750	600 600 500 600 100	2.5 1.0 10 10 0.1
1N1101	200	250	150	—55	150	—55	180	15	1.2	750	200	0.1
1N1102	300	250	150	—55	150	—55	180	15	1.2	750	300	0.1
1N1103	400	250	150	—55	150	—55	180	15	1.2	750	400	0.1
1N1104	500	250	150	—55	150	—55	180	15	1.2	750	500	0.1
1N1105	600	250	150	—55	150	—55	180	15	1.2	750	600	0.1
1N1169 1N1692 1N1693 1N1694 1N1695	400 100 200 300 400	300 250 250 250 250	100 100 100 100 100	—55 —55 —55 —55 —55	100 115 115 115 115	—55 —55 —55 —55 —55	180 175 175 175 175	35 20 20 20 20 20	1 0.6 0.6 0.6 0.6	300 250 250 250 250	400 100 200 300 400	100 500 500 500 500
1N1696	500	250	100	—55	115	—55	175	20	0.6	250	500	500
1N1697	600	250	100	—55	115	—55	175	20	0.6	250	600	500
1N1763	400	500	75	—65	100	—65	100	35	1	500	400	10
1N1764	500	500	75	—65	100	—65	100	35	1	500	500	10
PT505	50	1000	100	—55	125	—55	175	15	1.5	500	50	10
PT510	100	1000	100	—55	125	—55	175	50	1.5	500	100	10
PT515	150	1000	100	—55	125	—55	175	50	1.5	500	150	10
PT520	200	1000	100	—55	125	—55	175	50	1.5	500	200	10
PT525	250	1000	100	—55	125	—55	175	50	1.5	500	250	10
PT530	300	1000	100	—55	125	—55	175	50	1.5	500	300	10
PT540	400	1000	100	—55	125	—55	175	50	1.5	500	400	10
PT550	500	1000	100	—55	125	—55	175	50	1.5	500	500	10
PT560	600	1000	100	—55	125	—55	175	50	1.5	500	600	10
PT580	800	1000	50	—55	125	—55	175	50	1.5	500	800	10
S91	100	200	85	—55	125	—55	100	50	1.5	200	100	10
S91H	100	250	85	—55	125	—55	150	5 5 5 5 5	1.5	250	100	10
S92	200	200	85	—55	185	—55	100		1.5	200	200	10
S92H	200	250	85	—55	125	—55	150		1.5	250	200	10
S93	300	200	85	—55	185	—55	100		1.5	200	300	10
S93H	300	250	85	—55	125	—55	150		1.5	250	300	10

[·] Indicates MIL Type

Glass-Amp® SILICON RECTIFIERS

ass-Amp [©]	RECT	MAXIMUI REC' CUF 1/2 WAVE,	M AVERAGE TIFIED RENT RES. LOAD) Hz	OPERAT TEN RAN	IP.	STOI TEI RAI		MAXIMUM FORWARD PEAK SURGE CURRENT 1~, 60 Hz SUPERIMPOSED	FOR	IMUM WARD AGE @ 25°C	REV CURR RATI BLOO VOL	IMUM ERSE ENT @ ED DC CKING TAGE C AMB	MAXI REVE RECO @ 2	RSE VERY 5°C	JUNG CAPAC @ 2 * IND	ICAL CTION ITANCE 25°C ICATES AX
TYPE NUMBER	PRV VOLTS	mA	@ TA	MIN °C	MAX	MIN	MAX	Арк	VF VDC	IF mAdc	VR VDC	IR mAdc	REF. NOTE	μS	VR VDC	CJ pF
100B N4383 N4384 N4385 N4585	100 200 400 600 800	1000 1000 1000 1000 600	100 100 100 100 100	—65 —65 —65 —65 —65	175 175 175 175 175	—65 —65 —65 —65 —65	175 175 175 175 175	50 50 50 50 50	1.0 1.0 1.0 1.0 1.0	1000 1000 1000 1000 1000	100 200 400 600 800	10 10 10 10 10	=	=	=	===
N4586 N4250 N4251 N4252 N4253	1000 800 1000 1200 1500	600 500 500 500 500	100 55 55 55 55	—65 —65 —65 —65	175 160 160 160 160	—65 —65 —65 —65	175 200 200 200 200	50 10 10 10 10	1.0 2.0 2.0 2.0 2.0	1000 500 500 500 500	1000 800 1000 1200 1500	10 10 10 10	=	=	=	===
N4254 N4255 N4256 N4257 OG100J	1500 2000 2500 3000 1200	250 250 250 250 250 250	55 55 55 55 100	—65 —65 —65 —65 —55	160 160 160 160 150	—65 —65 —65 —65 —55	200 200 200 200 175	6.25 6.25 6.25 6.25 30	4.8 4.8 4.8 2.0	250 250 250 250 500	1500 2000 2500 3000 1200	10 10 10 10 5	=	=======================================	=======================================	=======================================
0G100K 0G100M (G100F (G100G (G100H	1600 2000 3000 4000 5000	250 250 150 150 150	100 100 50 50 50	—55 —55 —55 —55	150 150 150 150 150	—55 —55 —55 —55 —55	175 175 175 175 175	30 30 20 20 20	2.0 2.0 5.0 5.0 5.0	500 500 500 500 500	1600 2000 3000 4000 5000	5 5 5 5 5 5 5	=======================================	=======================================	=======================================	=
ndicates N	IL Type															
ass-Amp N5055 N5056 N5057	® FAS	1.0 1.0 0.7	50 50 50	—55 —55 —55	125 125 125	—55 —55 —55	175 175 175	30 30 30	1.3 1.3 1.3	1000 1000 1000	100 200 400	5 5 5	1 1 1	.2 .2 .4	-4 -4 -4	35 35 23
ass-Amp N5055 N5056 N5057	® FAS	1.0 1.0	50 50	—55 —55	125 125	55	175	30	1.3	1000	200	5	1	.2 .2 .4 .8	4 4 4 4	35 35 23 23
ndicates M lass-Amp 1N5055 1N5056 1N5057 1N5058	® FAS	1.0 1.0 0.7	50 50 50	—55 —55 —55	125 125 125	—55 —55	175 175	30 30	1.3 1.3	1000 1000	200 400	5 5	AVALA BREAM VOL	.4	-4 -4 -4 -4 -4 -4 -4 -4 -4 -4 -4 -4 -4 -	35 35 23 23 ASE IMUM Dus ILSE ANCHE WER
ass-Amp N5055 N5056 N5057 N5058	® FAS 100 200 400 400 600	1.0 1.0 0.7 0.7	50 50 50	—55 —55 —55 —55	125 125 125 125 125	—55 —55 —55	175 175 175 175	30 30	1.3 1.3	1000 1000	200 400	5 5	AVALA BREAM VOL	ANCHE COOWN	—4 —4 —4 —4 CA MAX 11 PU AVAL	35 35 23 23 ASE IMUM Dus ILSE ANCHE
ass-Amp N5055 N5056 N5057 N5058	® FAS 100 200 400 400 600	1.0 1.0 0.7 0.7	50 50 50 50	—55 —55 —55 —55	125 125 125 125 125	—55 —55 —55	175 175 175 175	30 30	1.3 1.3	1000 1000	200 400	5 5	AVALA BREAM VOL RAI	ANCHE KDOWN TAGE NGE	—4 —4 —4 —4 —4 C. MAX 11 PU AVAL PO	35 35 23 23 ASE IMUM Dus ILSE ANCHE WER
ass-Amp N5055 N5056 N5057 N5058	® FAS 100 200 400 600 8 CON 200 400 600	1.0 1.0 0.7 0.7 0.7	50 50 50 50 50	—55 —55 —55 —55 —55	125 125 125 125 125 125	—55 —55 —55 —55	175 175 175 175	30 30 30 30	1.3 1.3 1.3 1.3	1000 1000 1000	200 400 600	5 5 5 5	AVALABREAM VOLTARAI MAX V	ANCHE (DOWN TAGE NGE V 240 450	-4 -4 -4 -4 -4 -4 -4 -4 -4 -4 -4 -4 -4 -	35 35 23 23 ASE IMUM Dus ILSE ANCHI WER
ass-Amp N5055 N5056 N5057	® FAS 100 200 400 600 8 CON 200 400 600	1.0 1.0 0.7 0.7 0.7	50 50 50 50 50	—55 —55 —55 —55 —55	125 125 125 125 125 125	—55 —55 —55 —55	175 175 175 175	30 30 30 30	1.3 1.3 1.3 1.3	1000 1000 1000	200 400 600	5 5 5 5	AVALABREAM VOLTARAI MAX V	ANCHE (DOWN TAGE NGE V 240 450	-4 -4 -4 -4 -4 -4 -4 -4 -4 -4 -4 -4 -4 -	35 35 23 23 ASE IIMUM Dus ILSE ANCHI WER ATTS

LASTIC	RECTIFIE	ERS													CA	SE 3
1N2069 1N2070 1N2071 PA300 PA305	200 400 600 1000 50	500 500 500 500 500	100 100 100 50 50	65 65 65 65	100 100 100 125 125	65 65 65 65	125 125 125 150 150	22 22 22 15 15	1.2 1.2 1.2 1.5 1.5	500 500 500 500 500	200 400 600 1000 50	10 10 10 10 10	=	=======================================		
PA310 PA315 PA320 PA325 PA330	100 150 200 250 300	500 500 500 500 500	50 50 50 50	—65 —65 —65 —65	125 125 125 125 125	—65 —65 —65 —65	150 150 150 150 150	15 15 15 15 15	1.5 1.5 1.5 1.5 1.5	500 500 500 500 500	100 150 200 250 300	10 10 10 10 10	=	=	=======================================	= = =
PA340 PA350 PA380	400 500 800	500 500 500	50 50 50	—65 —65 —65	125 125 125	—65 —65 —65	150 150 150	15 15 15	1.5 1.5 1.5	500 500 500	400 500 800	10 10 10	Ξ	Ξ	Ξ	Ξ

Note: 1. When switched from 1 ampere forward current to -30 volts.

SILICON RECTIFIERS AND DIODES

STUD TYPE RECTIFIERS

CASE 34

		MAXIMUM AVERAGE RECTIFIED CURRENT 1/2 WAVE, RES. LOAD 60 Hz AAV ° TC		OPERATIONAL TEMP. RANGE		STORAGE TEMP. Range		MAXIMUM FORWARD PEAK SURGE CURRENT 1~, 60 Hz SUPERIMPOSED	MAXIMUM FORWARD VOLTAGE @ TA 25°C AMB		MAXIMUM REVERSE CURRENT @ RATED DC BLOCKING VOLTAGE @ 25°C AMB	
TYPE	PRV VOLTS	MA AAV	° Tc	MIN	MAX °C	MIN °C	MAX °C	Арк	VF VDC	IF mAdc	VR VDC	IR μ A DC
•1N253	100	1000	135	—55	150	—55	175	4.0	1.5	1000	175	10
•1N254	200	400	135	—55	150	—55	175	1.5	1.5	500	150	10
•1N255	400	400	135	—55	150	—55	175	1.5	1.5	500	350	10
•1N256	600	200	135	—55	150	—55	175	1.0	2.0	500	500	20
1N332	400	400	135	—55	150	—55	175	2.5	1.25	400	400	10
1N333 1N334 1N335 1N336 1N337	400 300 300 200 200	200 400 200 400 200	150 150 150 150 150	—55 —55 —55 —55 —55	175 175 175 175 175	—55 —55 —55 —55 —55	175 175 175 175 175	1.5 2.5 1.5 2.5 1.5	2.0 1.25 2.0 1.25 2.0	200 400 200 400 200	400 500 300 200 200	10 10 10 10
1N338	100	70	150	—65	175	—65	175	6.0	2.0	2000	100	10
1N339	100	400	150	—55	175	—55	175	2.5	1.25	400	100	10
1N340	100	200	150	—55	175	—55	175	1.5	2.0	200	100	10
1N341	400	400	150	—55	175	—55	175	2.5	1.25	400	400	10
1N342	400	200	150	—55	175	—55	175	1.5	2.0	200	400	10
1N343	300	400	150	—55	175	—55	175	2.5	1.25	400	300	10
1N344	300	200	150	—55	175	—55	175	1.5	2.0	200	300	10
1N345	200	400	150	—55	175	—55	175	2.5	1.25	400	200	10
1N346	200	200	150	—55	175	—55	175	1.5	2.0	200	200	10
1N347	100	70	150	—65	175	—65	175	6.0	2.0	200	100	10
1N348	100	400	150	—55	175	—55	175	2.5	1.25	400	100	10
1N349	100	200	150	—55	175	—55	175	1.5	2.0	200	100	10
1N562	800	400	25 AMB	—55	150	—55	175	1.5	1.3	400	800	1.5
1N563	1000	400	25 AMB	—55	150	—55	175	1.5	1.3	400	1000	2.0
1N2026	50	1000	150	—65	175	—65	175	25	2.0	2000	50	10
1N2027 1N2028 1N2029 1N2030 1N2031	200 300 400 500 600	1000 1000 1000 1000 1000	150 150 150 150 150	—65 —65 —65 —65	175 175 175 175 175	—65 —65 —65 —65	175 175 175 175 175	25 25 25 25 25 25	2.0 2.0 2.0 2.0 2.0	2000 2000 2000 2000 2000	200 300 400 500 600	10 10 10 10 10

GLASS DIODES

CASE 35

		MAXIMUM RECTIFIED 1/2 WAVE, R 60 F	CURRENT ES. LOAD	TEM	OPERATIONAL STORAGE PEAK SURGE C TEMP. TEMP. 1~, 60 RANGE RANGE SUPERIMPO		TEMP. 1~, 60 Hz RANGE SUPERIMPOSED		MAXI FORV VOLT @ TA	ARD AGE 25°C	MAXII REVERSE @ RA DC BLOCKIN @ 25°	CURRENT ATED IG VOLTAGE
TYPE	PRV VOLTS	MAV @	°C	MIN °C	MAX °C	MIN °C	MAX °C	Арк	VF VDC	IF mAdd	VR VDC	IR μ A DC
1N456 1N456A •1N457 1N457A •1N458	25 25 60 60 125	40 70 33 70 25	150 150 150 150 150	—65 —65 —65 —65 —65	175 175 175 175 175	—65 —65 —65 —65 —65	200 200 200 200 200 200	1 1 1 1 1	1.0 1.0 1.0 1.0	40 100 20 100 7	25 25 60 60 125	.025 .025 .025 .025 .025
1 N458A •1 N459 1 N459A 1 N461 1 N461A	125 175 175 25 25	70 18 70 27 70	150 150 150 150 150	—65 —65 —65 —65	175 175 175 175 175	—65 —65 —65 —65	200 200 200 200 200	1 1 1 1 1	1.0 1.0 1.0 1.0	100 3 100 15 100	125 175 175 175 25	.025 .025 .025 .50
1N462 1N462A 1N463 1N463A 1N464	60 60 175 175 125	22 70 13.5 70 18	150 150 150 150 150	—65 —65 —65 —65	175 175 175 175 175	—65 —65 —65 —65	200 200 200 200 200	1 1 1 1	1.0 1.0 1.0 1.0	5 100 1 100 3	25 60 60 175 175	.50 .50 .50 .50
1 N464A 1 N482 1 N482A 1 N482B 1 N483	125 36 36 36 70	70 100 200 200 100	150 25 25 25 25 25	—65 —55 —55 —55 —55	175 200 200 200 200	—65 —55 —55 —55 —55	200 200 200 200 200	1 1 2 2 2	1.0 1.1 1.0 1.0	100 100 100 100 100	175 30 30 30 60	.50 .25 .025 .025 .25
1N483A •1N483B 1N484 1N484A 1N484B	70 70 136 130 130	200 200 100 200 200	25 25 25 25 25 25	—55 —55 —55 —55 —55	200 200 200 200 200	—55 —55 —55 —55 —55	200 200 200 200 200	2 2 1 2 2	1.0 1.0 1.1 1.0 1.0	100 100 100 100 100	60 60 125 125 125	.025 .025 .25 .025 .025
1N485 1N485A •1N485B 1N486 1N486A •1N486B	180 180 180 225 225 225	100 200 200 100 200 200	25 25 25 25 25 25	—55 —55 —55 —55 —55	200 200 200 200 200 200	—55 —55 —55 —55 —55	200 200 200 200 200 200	1 2 2 1 2 2	1.1 1.0 1.0 1.1 1.0 1.0	100 100 100 100 100 100	175 175 175 225 225 225	.25 .025 .025 .25 .025 .025

[·]Indicates MIL Types

SILICON DIODES

GLASS DIODES CASE 35

		REC CUI 1/2 WAVE	M AVERAGE TIFIED RRENT , RES. LOAD O HZ	TE	TIONAL MP. NGE	TE	RAGE MP. NGE	MAXIMUM FORWARD PEAK SURGE CURRENT 1~, 60 Hz SUPERIMPOSED	FOR VOLT	IMUM WARD AGE @ 25°C MB	CURR RATE BLOC VOL	IMUM ERSE ENT @ ED DC EKING TAGE	MAXI REVI RECO @ 2	RSE VERY 5°C	@ 2	TION ITANCE 25°C ICATES
TYPE	PRV VOLTS	MA MA	@ TA	MIN	MAX	MIN	MAX	АРК	VF VDC	IF mADC	VR VDC	IR µADC	REF. NOTE	μs	VR VDC	CJ pF
1N487 1N487A 1N488 1N488A •1N645	300 300 380 380 225	100 200 100 200 150	25 25 25 25 25 150	65 65 65 65 65	200 200 200 200 200 175	65 65 65 65 65	200 200 200 200 200 200	1.0 2.0 1.0 2.0 5.0*	1.1 1.0 1.1 1.0 1.0	100 100 100 100 400	300 300 380 380 225	.25 0.1 .25 0.1 .025	=	E	= 4	
1N646 •1N647 1N648 •1N649 1N881 1N882	300 400 500 600 200 300	150 150 150 150 50 50	150 150 150 150 25 25	-65 -65 -65 -65 -65	175 175 175 175 150 150	65 65 65 65 65	200 200 200 200 200 200 200	5.0 5.0* 5.0 5.0* 0.5 0.5	1.0 1.0 1.0 1.0 1.0	400 400 400 400 50 50	300 400 500 600 200 300	0.2 .025 0.2 .050 20			4 4	20 20 —
1N883 1N884 1N885 1N886	400 500 600 700	50 50 50 50	25 25 25 25	65 65 65	150 150 150 150	—65 —65 —65 —65	200 200 200 200	0.5 0.5 0.5 0.5	1.0 1.0 1.0 1.0	50 50 50 50	400 500 600 700	20 20 20 20	=	=	=	=
1N887 1N888 1N889 1N890	800 900 1000 70	50 50 50 100	25 25 25 25	65 65 65 55	150 150 150 150	65 65 55	200 200 200 175	0.5 0.5 0.5 0.5	1.0 1.0 1.0 1.0	50 50 50 20	800 900 1000 70	20 20 20 .025	=	=	=	=
*At 150°C																

FAST R	ECOVERY	GLASS	DIODE	S											CA	SE 35
1N625 1N626 1N627 1N628 1N629	30 50 100 150 200	5 5 5 5 5	100 100 100 100 100	80 80 80 80	150 150 150 150 150	80 80 80 80 80	150 150 150 150 150	0.5 0.5 0.5 0.5 0.5	1.5 1.5 1.5 1.5 1.5	4 4 4 4	20 35 75 125 175	1 1 1 1	1 1 1 1	1.0 1.0 1.0 1.0	4.0 4.0 4.0 4.0 4.0	8.0 8.0 8.0 8.0 8.0
•1N643 1N643A •1N658 1N659 •1N660	175 175 100 50 100	40 40 200 100 100	25 25 25 25 25	—65 —65 —65 —65	150 150 175 175 175	—65 —65 —65 —65	150 150 200 200 200	0.5 0.5 0.6 0.5 0.5	1 1 1 1	100 100 100 6 6	100 100 50 50 100	1 .05 5 5	2 2 3 4 4	0.3 0.3 0.3 0.3	10 10 4.0 4.0 4.0	*3 *3 6.0 6.0 6.0
-1N661	200	100	25	-65	175	65	200	0.5	1	6	200	10	4	0.3	4.0	6.0
·1N662	85	100	25	—65	175	65	200	0.5	1	10	(50)	20	5	0.5	4.0	6.0
1N663 1N789 1N790	85 30 30	200 120 120	25 25 25	—65 —65 —65	175 150 150	—65 —65 —65	200 175 175	0.5 0.5 0.5	1 1 1	100 10 10	50 20 20	5 1 5	5 6 6	0.5 0.5 0.25	4.0 4.0 4.0	6.0 6.0
1N791 1N792 1N793 1N794 1N795	30 30 60 60	160 200 120 120 160	25 25 25 25 25	—65 —65 —65 —65	150 150 150 150 150	—65 —65 —65 —65	175 175 175 175 175	0.5 0.6 0.5 0.5	1 1 1 1	50 100 10 10 50	20 20 50 50	5 5 1 5	6 7 8 8	0.5 0.5 0.5 0.25 0.5	4.0 4.0 4.0 4.0	6.0 6.0 8.0 8.0
1N796 1N797 1N798 1N799 1N800	60 120 120 120 120	200 120 120 160 200	25 25 25 25 25	—65 —65 —65 —65	150 150 150 150 150	—65 —65 —65 —65	175 175 175 175 175	0.6 0.5 0.5 0.5 0.6	1 1 1 1	100 10 10 50 100	50 100 100 100 100	5 1 5 5 5	9 8 8 8	0.5 0.5 0.25 0.5 0.5	4.0 4.0 4.0 4.0 4.0	8.0 8.0 8.0 8.0
1 N801 1 N802 1 N803 1 N804 1 N891	150 150 200 200 50	120 160 120 160 200	25 25 25 25 25	—65 —65 —65 —65	150 150 150 150 175	—65 —65 —65 —65	175 175 175 175 200	0.5 0.5 0.5 0.5 0.6	1 1 1 1	10 50 10 50 50	125 125 125 125 125	1 5 5 10 0.1	8 8 8 8	0.5 0.5 0.5 0.5	4.0 4.0 4.0 4.0 4.0	8.0 8.0 8.0 8.0
1N892 1N893	100 200	200 200	25 25	—65 —65	175 175	—65 —65	200 200	0.6 0.6	1	50 50	100 200	0.1	3	.3	4.0 4.0	8.0

"W" SIN	GLE PH	ASE BI	RIDGE												CA	ASE 41
W005	50	1000	100	—55	125	— 55	150	50	1.0	1000	50	10	_	_	_	_
W02	200	1000	100	55	125	55	150	50	1.0	1000	200	10	_	_	_	_
W04	400	1000	100	55	125	-55	150	50	1.0	1000	400	10	_	_	_	-
W06	600	1000	100	55	125	-55	150	50	1.0	1000	600	10		_	_	_

- Notes: 1. To 400K ohms minimum measured in modified IBM "Y" test circuit when switched from 30mA forward current to —35 volts.

 2. To 200K ohms when switched from 5mA forward current (1 μs pulse) to —40 volts in JAN 256 circuit.

 3. To 80K ohms when switched from 5mA forward current to —40 volts in JAN 256 circuit.

 4. To 400K ohms when switched from 35mA forward current to —35 volts in JAN 256 circuit.

 5. To 100K ohms when switched from 5mA forward current to —40 volts in JAN 256 circuit.

- 6. To 200K ohms when switched from 5mA forward current to —20 volts in JAN 256 circuit.
 7. To 100K ohms when switched from to —20 volts in JAN 256 circuit.
 8. To 200K ohms when switched from 5mA forward current to —40 volts in JAN 256 circuit.
 9. To 100K ohms when switched from 5mA forward current to —40 volts in JAN 256 circuit.
- · Indicates MIL types.

SILICON RECTIFIERS AND DIODES

GLASS DIODES CAPSIL®

CASE 35

	MAXIMUM Working Volts @ 25°C	NOMINAL Capacitance @ —4 volts DC, 25°C	CAPACITANCE RANGE @ —4 VOLTS DC, 25°C	TE	ITIONAL MP. NGE	TE	RAGE MP. NGE	MIN. Q @ 50 MHz, —4 VOLTS DC, 25°C	Q 50 MHz, AND MAX. WORKING VOLTAGE 25°C
TYPE	VOLTS DC	pF	pF	MIN	MAX °C	MIN °C	MAX °C	Q	Q
CS7	25	.7	5.6-8.4	-65	175	-65	200	20 20 20 20 20	50
CS10	25 25 25	10	8.0-12.0	-65	175	65	200	20	50
CS12 CS15	25	12 15	9.6-14.4 12.0-18.0	—65 —65	175 175	—65 —65	200 200	20	50 50
IN3945	25	20	18.0-22.0	65	175	65	200	7	50
CS20	25 25	20	16.0-24.0	65	175	—65	200	20	50
CS27	25	27	21.6-32.4	-65	175	-65	200	20 18	45
CS30	25	30	24.0-36.0	65	175	65	200	18 18 7	45 45 20
CS33	25 25	30 33	26.4-39.6	-65	175	65	200	18	45
IN954	25	35	28.0-42.0	65	175	-65	200	7	20
CS40	25 25	40	32.0-48.0	65	175	65	200	18	45
CS47	25	47	37.6-56.4	65	175	-65	200	18 18 30	45
IN3628	15	50	47.0-53.0	-65	175	-65	200	30	-
IN955	25	50	40.0-60.0	-65	175	65	200	/	20
IN3488 CS56	15 15	56 56	50.4-61.6 44.8-67.2	—65 —65	175 175	—65 —65	200 200	16	25
CS68	15	68	54.4-81.6	—65 —65	175	 65	200	16	25 30
IN3947	9	68 70	56.0-84.0	65	175	65	200	9	30
IN3946	9	71	62.5-79.5	-65	175	-65	200	7	_
CS82	15	82	65.6-98.4	-65	175	-65	200	14	25
CS100	15	100	80.0-120.0	65	175	-65	200	12	20

ULTRA-FAST PLANAR COMPUTER DIODE

CASE 40

ТҮРЕ		MAXIMUM RECTI CURF 1/2 WAVE, 60 AAV (FIED RENT RES. LOAD Hz	OPERATEM RAN	AP.	STOR TEN RAN MIN °C	IP.	MAXIMUM FORWARD PEAK SURGE CURRENT 1 ~ 60 Hz SUPERIMPOSED APK	MAXI FORV VOLTA TA = AN VF VDC	ARD GE @ 25°C	MAXI REVE CURRE RATEI BLOCI VOLT 25° VR VDC	RSE NT @ D DC KING AGE	MAXI REVE RECO @ 2 AN REF.	RSE VERY 5°C	CAPACI	TION
GP101A GP101B GP102A GP102B GP103A GP103B GP104A	10 10 20 20 30 30 40	100 100 100 100 100 100	25 25 25 25 25 25 25	—65 —65 —65 —65 —65 —65	175 175 175 175 175 175 175	—65 —65 —65 —65 —65 —65	200 200 200 200 200 200 200	1 1 1 1 1 1	1 1 1 1 1 1	20 20 20 20 20 20 20	10 10 10 10 20 20 20	.05 .05 .05 .05 .05 .05	1 1 1 1 1 1	2 2 2 2 2 2 2 2	0 0 0 0 0 0 0	2 4 2 4 2 4 2
GP104A GP104B GP105A GP105B	40 40 50 50	100 100 100 100	25 25 25 25	—65 —65 —65	175 175 175 175	—65 —65 —65	200 200 200 200	1 1 1	1 1 1	20 20 20 20	20 20 20 20	.05 .05 .05	1 1 1	2 2 2	0	4 2 4

Note 1—When switched from 10 mA forward current to —6V in special computer test circuit. Recovery to 1 mA through loop impedance 100 ohms.

HERCULEADS*...The Ultimate Diode



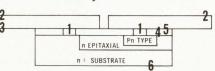
General Instrument's HERCULEADS beam-lead diode is a self-contained diode package with total environmental immunity — the smallest discrete diode available — and it is virtually indestructable.

- 1 Special low resistance contact area.
- 2 Gold leads. Lead mass large relative to mass of diode. Both leads on same face of chip.
- 3 Bonding area external to active device.
- Junction completely shielded by leads.
- 5 Oxide-passivation.
- 6 Silicon Chip

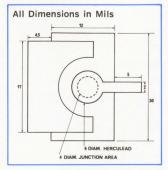
Electrical Specifications for XH100 SERIES at 25°C.

PRV	90V
11	40 mA @ 1V
1	2nA @ -40V
Ć	2.4 pf @ 0V
t	4 ns, 10ma, I _f to -40V

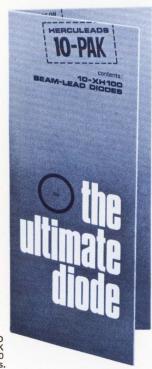
*Trade Mark



OUTLINE DRAWING



The HERCULEADS* BEAM-LEAD DIODE is sold as a 10-PAK package containing 10-XH100 beam-lead diodes.



ZENER VOLTAGE REGULATOR DIODES

200	mW	TYPES
-	-	

C	AS	F	39	
_	MJ	-	37	

ТҮРЕ	POWER RATING		ZENER VOLTS @ IZT	TEST CUR- RENT IZT	MAXI DYN/ IMPEI (See N @ IZT	MIC	TEST CUR- RENT IZK	CUR @ 2	ERSE RENT 25°C @ VR
TIPE	mW	NOTES	VOLTS	mA	OHMS	OHMS	mA	μA	VOLTS
1N225 1N226 1N227 1N228 1N229	200 200 200 200 200	2 2 2 2 2	7.5-10 9-12 11-14.5 13.5-18 17-21	0.2 0.2 0.2 0.2 0.2				0.5 0.5 0.5 0.5 0.5	6.8 8.2 10 12 15
1N230 1N231 1N232 1N233 1N234	200 200 200 200 200	2 2 2 2 2	20-27 25-32 30-39 37-45 43-54	0.2 0.2 0.2 0.2 0.2				0.1 0.1 0.1 0.1 0.1	18 22 27 33 39
1N235 1N236 1N237 1N238 1N239	200 200 200 200 200	2 2 2 2 2	52-64 62-80 75-100 90-120 110-145	0.2 0.2 0.2 0.2 0.2				0.1 1 1 1 1	47 56 68 82 100
1N465 1N466 1N467 1N468 1N469	200 200 200 200 200	3 3 3 3 3	2-3.2 3-3.9 3.7-4.5 4.3-5.4 5.2-6.4	5 5 5 5 5		60 55 45 35 20	10 10 10 10	75 50 5 5	1 1 1.5 1.5
1N470 1N471 1N472 1N473 1N474 1N475	200 200 200 200 200 200	3 2 2 2 2 2 2	6.2-8.0 3-3.9 3.7-4.5 4.3-5.4 5.2-6.4 6.2-8.0	555555		10 65 60 50 40 25	10 10 10 10 10	5 50 5 5 5 5	3.5 1 1 1.5 1.5 3.5

1N475	200	2	6.2-8.0	5		25	10	5	3.5
250 mW	TYPES							CASI	E 39
1N702 1N703 1N704 1N705 1N706	250 250 250 250 250	4 4 4 4 4	2-3.2 3-3.9 3.7-4.5 4.3-5.4 5.2-6.4	5 5 5 5 5 5		60 55 45 35 30	10 10 10 10 10	75 50 5 5	1 1 1.5 1.5
1N707 1N708 1N709 1N710 1N711	250 250 250 250 250	4 4 4 4	6.2-8.0 5.6 6.2 6.8 7.5	5 25 25 25 25	3.6 4.1 4.7 5.3	10	10	5	3.5
1N712 1N713 1N714 1N715 1N716	250 250 250 250 250	4 4 4 4 4	8.2 9.1 10 11 12	25 12 12 12 12	6 7 8 9 10				
1N717 1N718 1N719 1N720 1N721	250 250 250 250 250	4 4 4 4	13 15 16 18 20	12 12 12 12 12 4	11 13 15 17 20				
1N722 1N723 1N724 1N725 1N726	250 250 250 250 250	4 4 4 4 4	22 24 27 30 33	4 4 4 4	24 28 35 42 50				
1N727 1N728 1N729 1N730 1N731	250 250 250 250 250	4 4 4 4 4	36 39 43 47 51	4 4 4 4	60 70 84 98 115				
1N732 1N733 1N734 1N735 1N736	250 250 250 250 250	4 4 4 4	56 62 68 75 82	4 2 2 2 2	140 170 200 240 280				
1N737 1N738 1N739 1N740 1N741	250 250 250 250 250	4 4 4 4	91 100 110 120 130	1 1 1 1 1	340 400 490 570 650				

[·] Indicates MIL Type.

Notes: 1. Unless otherwise specified in notes, dynamic impedance is measured by superimposing alternating current equal to 10% of the direct current IZT or IZK.

- 2. 10% tolerance: suffix A = 5%, Double anode type.
- 3. 10% tolerance: suffix A =5%, suffix B = 1%.

- 4. 10% tolerance: suffix A = 5%.
- 5. 10% tolerance: suffix A = 5%. For dynamic impedance superimpose 1mA ac upon $\rm Izr$
- 6. 10% tolerance.
- 7. 20% tolerance: suffix A = 10%, suffix B = 5%.

250 mW TYPES Cont'	250	mW	TYPES	Cont'o
--------------------	-----	----	--------------	--------

CASE 39

TYPE	POWER RATING		ZENER VOLTS @ IZT	TEST CUR- RENT IZT		MIC	TEST CUR- RENT IZK	CUI	VERSE RRENT 25°C @ VR
	mW	NOTES	VOLTS	mA	OHMS	OHMS	mA	μA	VOLTS
1N742 1N743 1N744 1N745 1N761	250 250 250 250 250	4 4 4 4 6	150 160 180 200 4.3-5.4	1 1 1 1 10	860 970 1200 1400 40				
1N762 1N763 1N764 1N765 1N766	250 250 250 250 250	6 6 6 6	5.2-6.4 6.2-8.0 7.5-10 9-12 11-14.5	10 10 10 5 5	18 7 12 45 55				
1N767 1N768 1N769 1N3477	250 250 250 250	6 6 6 4	13.5-18 17-21 20-27 2.2	5 5 5 5	70 100 150 60				

400 mW	TYPES							CA	SE 39
•1N746A •1N747A •1N748A •1N749A •1N750A	400 400 400 400 400	55555	3.3 3.6 3.9 4.3 4.7	20 20 20 20 20	28 24 23 22 19			5 5 5 5 10	1.0 1.0 1.0 1.0 2.0
•1N751A •1N752A •1N753A •1N754A •1N755A	400 400 400 400 400	55555	5.1 5.6 6.2 6.8 7.5	20 20 20 20 20	17 11 7 5 6			10 10 10 5 5	2.0 3.0 4.0 5.0 6.0
•1N756A •1N757A •1N758A •1N759A 1N957	400 400 400 400 400	5 5 5 5 7	8.2 9.1 10 12 6.8	20 20 20 20 18.5	8 10 17 30 4.5	700	1.0	5 5 5 5	6.5 7.0 8.0 9.0
1N958 1N959 1N960 1N961 •1N962B	400 400 400 400 400	7 7 7 7 7	7.5 8.2 9.1 10 11	16.5 15 14 12.5 11.5	5.5 6.5 7.5 8.5 9.5	700 700 700 700 700	0.5 0.5 0.5 0.25 0.25		
•1N963B •1N964B •1N965B •1N966B •1N967B	400 400 400 400 400	7 7 7 7 7	12 13 15 16 18	10.5 9.5 8.5 7.8 7.0	11.5 13 16 17 21	700 700 700 700 750	0.25 0.25 0.25 0.25 0.25		
•1N968B •1N969B •1N970B •1N971B •1N972B	400 400 400 400 400	7 7 7 7 7	20 22 24 27 30	6.2 5.6 5.2 4.6 4.2	25 29 33 41 49	750 750 750 750 750 1000	0.25 0.25 0.25 0.25 0.25		
•1N973B •1N974B •1N975B •1N976B •1N977B	400 400 400 400 400	7 7 7 7 7	33 36 39 43 47	3.8 3.4 3.2 3.0 2.7	58 70 80 93 105	1000 1000 1000 1500 1500	0.25 0.25 0.25 0.25 0.25		
•1N978B •1N979B •1N980B •1N981B •1N982B	400 400 400 400 400	7 7 7 7 7	51 56 62 68 75	2.5 2.2 2.0 1.8 1.7	125 150 185 230 270	1500 2000 2000 2000 2000	0.25 0.25 0.25 0.25 0.25		
·1N983B ·1N984B ·1N985B ·1N986B ·1N987B	400 400 400 400 400	7 7 7 7 7	82 91 100 110 120	1.5 1.4 1.3 1.1 1.0	330 400 500 750 900	3000 3000 3000 4000 4500	0.25 0.25 0.25 0.25 0.25		
·1N988B ·1N989B ·1N990B ·1N991B ·1N992B	400 400 400 400 400	7 7 7 7 7	130 150 160 180 200	.95 .85 .80 .68	1100 1500 1700 2200 2500	5000 6000 6500 7100 8000	0.25 0.25 0.25 0.25 0.25		

ZENER VOLTAGE REGULATOR DIODES

1 WATT FLANGELESS TYPES

CASE 36

1 WATT Glass-Amp®

CASE 38

	POWER		ZENER VOLTS @ IZT	TEST CUR- RENT IZT	DYN	DANCE	TEST CUR- RENT IZK	CUR @	ERSE RENT 25°C @ VR
TYPE	(Watts)	NOTE	VOLTS	mA	OHMS	OHMS	mA	μA	VOLT
•1N3021 •1N3022 •1N3023 •1N3024 •1N3025	1 1 1 1	1 1 1 1	11 12 13 15 16	23 21 19 17 15.5	8 9 10 14 16	700 700 700 700 700	0.25 0.25 0.25 0.25 0.25	10 10 10 10	1
•1N3026 •1N3027 •1N3028 •1N3029 •1N3030	1 1 1 1	1 1 1 1	18 20 22 24 27	14 12.5 11.5 10.5 9.5	20 22 23 25 35	750 750 750 750 750	0.25 0.25 0.25 0.25 0.25	10 10 10 10	
•1N3031 •1N3032 •1N3033 •1N3034 •1N3035	1 1 1 1	1 1 1 1	30 33 36 39 43	8.5 7.5 7 6.5 6	40 45 50 60 70	1000 1000 1000 1000 1500	0.25 0.25 0.25 0.25 0.25	10 10 10 10	E 2
•1N3036 •1N3037 •1N3038 •1N3039 •1N3040	1 1 1 1	1 1 1 1	47 51 56 62 68	5.5 5 4.5 4 3.7	80 95 110 125 150	1500 1500 2000 2000 2000	0.25 0.25 0.25 0.25 0.25	10 10 10 10	SEE NOTE
•1N3041 •1N3042 •1N3043 •1N3044 •1N3045	1 1 1 1	1 1 1 1 1	75 82 91 100 110	3.3 2.8 2.5 2.3	175 200 250 350 450	2000 3000 3000 3000 4000	0.25 0.25 0.25 0.25 0.25	10 10 10 10	
•1N3046 •1N3047 •1N3048 •1N3049 •1N3050 •1N3051	1 1 1 1 1	1 1 1 1 1 1	120 130 150 160 180 200	2 1.9 1.7 1.6 1.4 1.2	550 700 1000 1100 1200 1500	4500 5000 6000 6500 7000 8000	0.25 0.25 0.25 0.25 0.25 0.25	10 10 10 10 10	

	POWER RATING		ZENER VOLTS @ IZT	TEST CUR- RENT IZT	DYN/ IMPEI (See N @ IZT	AMIC	TEST CUR- RENT IZK	CUR @	ERSE RENT 25°C @ VR
TYPE	(Watts)	NOTE	VOLTS	mA	OHMS	OHMS	mA	μA	VOLT
1N4162 1N4163 1N4164 1N4165 1N4166	1 1 1 1	1 1 1 1	10 11 12 13 15	25 23 21 19 17	7 8 9 10 14	700 700 700 700 700	0.25 0.25 0.25 0.25 0.25	10 5 5 5 5	1
1N4167 1N4168 1N4169 1N4170 1N4171	1 1 1 1	1 1 1 1	16 18 20 22 24	15.5 14 12.5 11.5 10.5	16 20 22 23 25	700 750 750 750 750	0.25 0.25 0.25 0.25 0.25	55555	
1N4172 1N4173 1N4174 1N4175 1N4176	1 1 1 1	1 1 1 1 1	27 30 33 36 39	9.5 8.5 7.5 7.0 6.5	35 40 45 50 60	750 1000 1000 1000 1000	0.25 0.25 0.25 0.25 0.25	55555	2
1N4177 1N4178 1N4179 1N4180 1N4181	1 1 1 1	1 1 1 1 1	43 47 51 56 62	6.0 5.5 5.0 4.5 4.0	70 80 95 110 125	1500 1500 1500 2000 2000	0.25 0.25 0.25 0.25 0.25	55555	SEE NOTE
1N4182 1N4183 1N4184 1N4185 1N4186	1 1 1 1	1 1 1 1 1	68 75 82 91 100	3.7 3.3 3.0 2.8 2.5	150 175 200 250 350	2000 2000 3000 3000 3000	0.25 0.25 0.25 0.25 0.25	5 5 5 5 5	
1N4187 1N4188 1N4189 1N4190 1N4191 1N4192 1N4193	1 1 1 1 1 1	1 1 1 1 1 1	110 120 130 150 160 180 200	2.3 2.0 1.9 1.7 1.6 1.4	450 550 700 1000 1100 1200 1500	4000 4500 5000 6000 6500 7000 8000	0.25 0.25 0.25 0.25 0.25 0.25 0.25	5555555	

·Available in MIL Type.

Note: 1. 20% tolerance: suffix A = 10%, suffix B = 5%. 2. $V_R = V_Z \times [100 - (\% \text{ tolerance})] \times 0.8 \times 1/100$

Glass-Amp®

- Handles one full ampere at 100°C; PRV to 1,000V
- Miniature Space-Saver Symmetrical package (only .150" x .360")

STILL THE INDUSTRY'S MOST POPULAR 1-AMP SILICON RECTIFIER

OVER 50 MILLION NOW IN USE!

- Fully insulated, hermetically sealed body mounts directly on PC boards.
- Withstands 50-ampere surge current

GERMANIUM TRANSISTORS

GERMANIUM COMPUTER TRANSISTORS/INTERMEDIATE TO HIGH CURRENT/MEDIUM SPEED D.C. SWITCHING

RATINGS AT 25°C AMBIENT TEMPERATURE (UNLESS OTHERWISE SPECIFIED)

				MAXIMUM @ 2			lo	СВО		TIC FORWARD			Alpha	
	Delavitu		Pc			VCEO *VCES #VCER	Van		TEST CON	DITIONS	LI	MITS	Cutoff Frequency	Collector Capacity
TYPE	Polarity P-PNP N-NPN	Case	@25°C VCBO Volts		CBO VEBO +VCEX		VCB Volts	Max. μA	IC mA	VCE Volts	Min.	Max.	Min. MHz	Max. pF
2N315A 2N316 2N316A 2N356 2N356A	P P P N N	66666	150 100 150 100 150	30 20 30 20 30	20 20 20 20 20	20 10 15 18 20	5 5 5 5 5	2 2 2 5 5	100 200 200 100 100	0.2 0.2 0.2 0.25 0.25	20 20 20 20 20 20	50 50 50 50 50	θ5 θ12 θ12 θ3 θ3	$egin{array}{c} heta 14 \\ heta 14 \\ heta 14 \\ heta 14 \\ heta 14 \end{array}$
2N357A 2N358 •2N358A 2N377A 2N388A	N N N N N N N N N N N N N N N N N N N	6 6 6 (G.B.) 6 (G.B.)	150 100 150 150 150	30 20 30 40 40	20 20 20 15 15	20 12 15 +40 #20	5 5 1.0 1.0	5 5 5 5 5	200 300 300 200 200	0.25 0.25 0.25 0.75 0.75	25 20 25 20 30	75 50 75	$egin{array}{c} heta 6 \ heta 9 \ heta 9 \ heta 6 \ heta 5 \end{array}$	$egin{array}{c} heta 14 \\ heta 14 \\ heta 14 \\ heta 20 \\ heta 20 \end{array}$
•2N396A 2N579 2N580 •2N1306 •2N1307	P P P P P	6 (G.B.) 6 6 (G.B.) 6 (G.B.)	200 150 150 150 150	30 20 20 25 30	20 12 20 25 25	20	20 12 12 25 25	65566	200 400 400 200 200	0.35 0.3 0.3 0.35 0.35	15 20 30 20 20	150	5 5 10 10 10	20 20 20

COMPUTER TRANSISTORS/MEDIUM CURRENT FOR MEDIUM SPEED D.C. SWITCHING

•2N404 •2N404A 2N438A 2N439A 2N440A	P P N N N	6 6 6 (G.B.) 6 6	150 150 150 150 150	25 40 30 30 30	12 25 25 25 25	25 25 15	12 12 25 25 25	5 5 10 10 10	50 50 50	1.0 1.0 1.0	20 30 40		4 4 2.5 5 10	20 20 20 20 20
2N444A 2N445A 2N446A 2N447A 2N519A	N N N P	6 6 6 6	150 150 150 150 150	40 30 30 30 30 25	10 10 10 10 10	25 18 15 12 18	5 5 5 5 5	4 4 4 4 2	20 20 20 20 20	0.25 0.25 0.25 0.25 0.25	20 40 60 80 20	40 160 250 300 50	0.5 2 5 9 0.5	$egin{array}{c} heta 14 \\ heta 14 \\ heta 14 \\ heta 14 \end{array}$
2N520A 2N521A 2N522A 2N523A 2N585	P P P P N	6 6 6 6	150 150 150 150 150	25 25 25 20 25	10 10 10 10 20	15 12 10 6	5 5 5 2.5	2 2 2 2 6	20 20 20 20 20 20	0.25 0.25 0.25 0.25 0.2	40 60 80 100 20	170 250 320 400	3 8 15 21 3	$egin{array}{c} heta 14 \\ heta 14 \\ heta 14 \\ heta 20 \end{array}$

MEDIUM POWER ALLOY JUNCTION TRANSISTORS FOR SWITCHING AND AMPLIFIER APPLICATIONS

2N597	P	6	250	45	45	*40	1.5	5	100	1.0	40	225	3	20
•2N598	P	6	250	35	30	*35	1.5	5	100	1.0	70		5fT	20
•2N599	P	6	250	30	20	*20	1.5	5	100	1.0	100		10fT	20
•2N600 2N601 2N2648	P P P	Fig. 12 Fig. 12 6 (G.C.)	750 750 300	35 30 35	30 20 30	*35 *20 10	1.5 1.5 15	5 5 5	100 100 1.0A	1.0 1.0 0.5	70 100 80	225 500	5fT 10fT 10fT	20 20 30

HIGH VOLTAGE TRANSISTORS FOR NIXIE AND OTHER NEON TUBE DRIVERS

2N39 •2N13 2N13 2N13	10 N 11 N	6 6	150 150 150 150	90 75	50 20 20 20	*105	2.5 5 5	14 7 7 7	5 5 5 5	0.35 0.25 0.25 0.25	20 20 15 15	$egin{array}{c} heta 1.0 \ heta 1.5 \ heta 1.5 \end{array}$	$\begin{array}{c} \theta 11 \\ \theta 11 \\ \theta 11 \end{array}$
2N14		6	150		10		5	7		0.20	10	01.5	θ35

BILATERAL TRANSISTORS FOR CORE AND DRUM MEMORY ADDRESSING CHOPPER SERVICE

					Description of				IB				
2N594	N	6	150	20	20	20	5	5	1.0	0.2	20	1.5	$\begin{array}{c} \theta 15 \\ \theta 15 \\ \theta 15 \end{array}$
2N595	N	6	150	20	20	15	5	5	1.0	0.2	35	3	
2N596	N	6	150	20	20	10	5	5	1.0	0.2	50	5	

AUDIO TRANSISTORS FOR AUDIO AND LOW SPEED COMPUTER APPLICATIONS

				MAXI	MUM RAT @ 25°C	INGS	Ic	во		A.C.	CURRENT			ALPHA CUTOFF	
	Polarity		Pc						C	ONDITIONS		LIN	AITS	Frequency fhfb	
TYPE	TYPE P-PNP Case			@ 25°C mW	VCBO Volts	VEBO Volts	VCEO Volts	V _{CB} Volts	Max. μA	IC mA	VCE Volts	Freq. kHz	Min.	Max.	Min. MHz
·2N331	Р	6	150	30	12				1	6	1	30	70	0.4	
·2N464	P	6	150	45	12	40	20	15	1	6	1	14		θ 0.7	
·2N465	P	6	150	45	12	30	20	15	1	6	1	27		θ 0.8	
·2N466	P	6	150	35	12	20	20	15	1	6	1	56		θ 1.0	
·2N467	P	6	150	35	12	15	20	15	1	6	1	112		θ 1.2	

Notes: θTypical Values

· Available to Military Specifications

G.B. - Base Connected to Case

G.C. - Collector Connected to Case

SILICON TRANSISTORS

				MAXII	MUM RA @ 25°C	TINGS		VARD CURR		VI	BE	VCE	(SAT)	GAIN BAND-	COLLECTOR
TYPE	CASE	POLARIT P—PNF N—NPI	@ 25°C	VCBO VOLTS	VEBO VOLTS	+VCER VOLTS	IC mA	MIN.	MAX.	Ic mA	VOLTS MAX.	Ic mA	VOLTS MAX.	FT MIN.	CAPACITY Cob MAX. pF
HIGH SP	EED :	SWITCH	IES												
2N706	9	N	300	25	3	+20 15	10	20		10	0.9	10	0.6	200	6
2N706A	9	N	300	25	5	+20 15	10	20	60	10	0.9	10	0.6	200	5
2N706B	9	N	300	25	5	+20 15	10	20	60	10	0.9	10	0.4	200	5
2N708 2N743	9	N	360 300	40 20	5 5	+20 12	10 10	30 20	120 60	10 10	0.8	10	0.4	300 280	6 5
2N744	9	N	300	20	5	12 15	10	40	120	10	0.85			280	5
2N753 2N834	9	N	300	25 40	5 5	+20	10 10	40 25	120	10 10	0.9	10 10	0.6 0.25	200 350	5 4
LOW LEV	9 'FI I	OW N	OISE AMP	25 LIFIER	3	20	10	20		10	0.9	10	0.3	300	4
2N929	9	N	300	45	5	45	0.01	40	120	10	1.0	10	1.0	30	8
2N929A 2N930	9	N	300 500	60 45	6 5	45 45	0.01	40 100	120 300	10 10	0.9	10 10	0.5 1.0	45 30	6 8
2N930A 2N2483	9	N	500 360	60 60	6	45 60	0.01	100 40	300 120	10 0.1	0.9	10 1.0	0.5 0.35	45 60	6
2N2484	9	N	360	60	6	60	0.01	100	500	0.1	0.7	0.1	0.35	60	6
CORE DR	IVER					30									
2N2537	6	N	800	60	5	30 +40 30	500	20		500	2.6	500	1.6	250	8
2N2538	6	N	800	60	5	+40 30	500	30		500	2.6	500	1.6	250	8
2N2539 2N2540	9	N	500	60 60	5	+40 30	500 500	20 30		500 500	2.6	500	1.6	250 250	8
GENERAL		POSE,	MEDIUM	SPEED.	MEDI	H40	VER AM		AND	SWITCHI		300	1.0	230	•
2N696	6	N	600	60	5	+40	150	20	60	150	1.3	150	1.5	40	35
2N697 2N698	6	N N	600 800	60 120	5 7	+40 60	150 150	40 20	120	150 150	1.3	150 150	1.5 5	50 40	35 15
2N699 2N718	6	N	600	120	5	+80 +80	150	40	120	150	1.3	150	5 1.5	50	20 35
2N718A	9	N	400 500	60 75	5 7	+40	150 150	40 40	120	150 150	1.3	150 150	1.5	50 60	25
2N721	9	Р	400	50	5	+50 35 +50	150	20	45	150	1.3	150	1.5	50	45
2N722	9	Р	400	50	5	35 +50	150	30	90	150	1.3	150	1.5	60	45
2N1131	6	Р	600	50	5	35 +50	150	20	45	150	1.3	150	1.5	50	45
2N1132	6	Р	600	50	5	35 +50	150	30	90	150	1.3	150	1.5	60	45
2N1613 2N1711	6	N	800 800	75 75	7	+50 +50	150 150	40 100	120 300	150 150	1.3 1.3	150 150	1.5 1.5	60 70	25 25
2N1893	6	N	800	120	7	80 +100	150	40	120	150	1.3	150	5	50	15
2N2192 2N2192A	6	N	800 800	60 60	5 5	40 40	150 150	100 100	300 300	150 150	1.3 1.3	150 150	0.35 0.25	50 50	20 20
2N2192B 2N2193	6	N	800 800	60 80	5	40 50	150 150	100 40	300 120	150 150	1.3 1.3	150 150	0.18 0.35	50 50	20 20
2N2193A 2N2193B	6	N	800 800	80 80	8	50 50	150 150	40 40	120 120	150 150	1.3	150 150	0.25 0.18	50 50	20
2N2217	6	N	800	60	5	30	150	20	60	150	1.3	150	0.4	250	8
2N2218 2N2218A 2N2219	6 6	2 2 2	800 800 800	60 75 60	5 6 5	30 40 30	150 150 150	40 40 100	120 120 300	150 150 150	1.3 1.2 1.3	150 150 150	0.4 0.3 0.4	250 250 250	8 8 8
2N2219A 2N2220	6	N	800 500	75 60	6 5	40 30	150 150	100	300	150 150	1.2	150 150	0.3	300 250	8 8
2N2221	9	N	500	60	5	30	150	40	120	150	1.3	150	0.4	250	8
2N2221A 2N2222 2N2222A	9 9	N	500 500 500	75 60	6 5	40 30 40	150 150 150	40 100 100	120 300 300	150 150 150	1.2 1.3 1.2	150 150 150	0.3 0.4 0.3	250 250 300	8 8 8
2N2303	6	N P	600	75 50	6 5	35 +50	150	75	200	150	1.3	150	1.5	60	45
2N2837	9	Р	500	50	5	35	150	30	90	150	1.3	150	0.4	120	25
2N2838 2N2904	9	P P	500 600	50 60	5	35 40	150 150 500	75 40 20	225 120	150 150 500	1.3 1.3 2.6	150 150 500	0.4 0.4 1.6	120 200	25 8
2N2904A	6	Р	600	60	5	60	150 500	40 40	120	150 500	1.3	150 500	0.4 1.6	200	8
2N2905	6	Р	600	60	5	40	150 500	100 30	300	150 5 JO	1.3	150 500	0.4	200	8
2N2905A	6	Р	600	60	5	60	150 500	100 50	300	150 500	1.3 2.6	150 500	0.4	200	8
2N2906	9	Р	400	60	5	40	150 500	40 20	120	150 500	1.3	150 500	0.4	200	8
2N2906A	9	Р	400	60	5	60	150 500	40 40	120	150 500	1.3 2.6	150 500	0.4 1.6	200	8
2N2907	9	Р	400	60	5	40	150 500	100 30	300	150 500	1.3 2.6	150 500	0.4	200	8
2N2907A	9	P	400	60	5	60	150 500	100 50	300	150 500	1.3 2.6	150 500	0.4	200	8
2N3133 2N3134	6	P	600 600	50 50	4	35 35	150 150	40 100	120 300	150 150	1.5	150 150	0.6	200 200	10 10
2N3135 2N3136	9	P P	400 400	50 50	4	35 35	150 150	100	120 300	150 150	1.5 1.5	150 150	0.6 0.6	200 200	10 10

EPOXY ENCAPSULATED TRANSISTORS

EPOXY ENCAPSULATED TRANSISTORS

CASE 42

	POLARITY N-NPN	Vсво	VCEO	VEBO	hFE	@ V CE	. Ic	h _{fe}	@ V CE	lc	ft	Cob @	VCB	VCE (SAT)	VCE @ IC	В	PD
TYPE*	P—PNP	VOLTS	VOLTS	VOLTS		VOLTS	mA		VOLTS	mA	MHz	pF	VOLTS	VOLTS	mA	mA	mW
2N2711 2N2712 2N2713 2N2714 2N2715	2 2 2 2 2	18 18 18 18 18	18 18 18 18	5.0 5.0 5.0 5.0 5.0	30-90 75-125 30-90 75-225 30-90	4.5 4.5 4.5 4.5 4.5	2 2 2 2 2	30-120 80-300 30-120 80-300 30-120	4.5 4.5 4.5 4.5 4.5	2 2 2 2 2	=	4.5-12 4.5-12 — 5.0	10 10 — 10	.30	50 50	3 3	200 200 200 200 200
2N2716 2N2921 2N2922 2N2923 2N2924	N N N N N N N N N N N N N N N N N N N	18 25 25 25 25 25	18 25 25 25 25	5.0 5.0 5.0 5.0 5.0	75-225 — — — —	4.5	<u>2</u> 	80-300 35-70 55-110 90-180 150-300	4.5 10 10 10 10	2 2 2 2 2	=	5.0 4.5-12 4.5-12 4.5-12 4.5-12	10 10 10 10	=	=	Ξ	200 200 200 200 200
2N2925 2N2926 2N3390 2N3391 2N3391A	N N N N N N N N N N N N N N N N N N N	25 18 25 25 25	25 18 25 25 25	5.0 5.0 5.0 5.0 5.0	400-800 250-500 250-500	 4.5 4.5 4.5		235-470 35-470 400-1250 250-800 250-800	10 10 —	2 2	Ξ	4.5-12 4.5-12 4.5-10 4.5-10 4.5-10	10 10 10 10	=	=======================================	===	200 200 200 200 200
2N3392 2N3393 2N3394 2N3395 2N3396	N N N N N N N N N N N N N N N N N N N	25 25 25 25 25	25 25 25 25 25	5.0 5.0 5.0 5.0 5.0	150-300 90-180 55-110 150-500 90-500	4.5 4.5 4.5 4.5 4.5	2 2 2 2 2	150-500 90-400 55-300 150-800 90-800	=	=	Ē	4.5-10 4.5-10 4.5-10 4.5-10 4.5-10	10 10 10 10	=	=	=======================================	200 200 200 200 200
2N3397 2N3398 2N3414 2N3416 2N3563	N N N N N N N N N N N N N N N N N N N	25 25 25 50 30	25 25 25 50 12	5.0 5.0 5.0 5.0 4.0	55-500 55-800 75-225 75-225 20-200	4.5 4.5 4.5 4.5 10	2 2 2 2 8	55-800 55-1250 75 75 20-250				4.5-10 4.5-10 — — 1.7	10 10 — 10	.30	50 50	3 3	200 200 360 360 200
2N3564 2N3565 2N3566 2N3605 2N3606	N N N N	30 30 40 18 18	15 25 30 14 14	4.0 6.0 5.0 5.0 5.0	20-500 150-600 150-600 30 30	10 10 10 1	15 1 10 10 10	120-750 — —	5	<u>1</u>	400-1200 40-240 40-240 300 300	3.5 4.0 25 6.0 6.0	10 5.0 10 10	.30 1.0 .25 .25	20 100 10 10	2 10 1 1	200 200 300 200 200
2N3607 2N3638 2N3638A 2N3641 2N3643	N P P N N	18 25 50 60	14 25 50 30 30	5.0 4.0 4.0 5.0 5.0	30 30 30-180 40-120 100-300	1 1 1 10 10	10 50 50 150 150	25 25 —	10 10 —	10 10 —	300 100 100 250 250	6.0 20 10 8.0 8.0	10 10 10 10	.25 1.0 1.0 .22 .22	10 300 300 150 150	1 30 30 15 15	200 300 300 350 350
2N3644 2N3645 2N3662 2N3663 2N3691	P P N N N	45 60 18 30 35	45 60 12 12 20	5.0 5.0 3.0 3.0 4.0	100-300 100-300 20 20 40-160	10 10 10 10	150 150 8 8		_ _ _ _ 10	_ _ _ 5	200 200 700-2100 700-2100 200-500	8.0 8.0 .8-1.7 .8-1.7 .5-3.5	10 10 10 10	.25 .25 	50 50 — — 10	2.5 2.5 — 1	300 300 200 200 200
2N3692 2N3702 2N3703 2N3704 2N3705	N P P N	35 40 50 50 50	20 25 30 30 30	4.0 5.0 5.0 5.0 5.0	100-400 60-300 30-150 100-300 50-150	1 5 5 3 2	10 50 50 50 50	100-560	10 	5	200-500 100 100 100 100	.5-3.5 12 12 12 12 12	10 10 10 10	.70 .25 .25 .60	10 50 50 100 100	1 5 5 5 5	200 300 300 360 360
2N3706 2N3707 2N3708 2N3709 2N3710	N N N N	40 30 30 30 30	20 30 30 30 30	5.0 6.0 6.0 6.0	30-600 100-400 45-660 45-165 90-330	2 5 5 5 5	50 .1 1 1	100-550 45-800 45-250 90-450	5 5 5 5	.1 1 1 1	100 	12 	10	1.0 1.0 1.0 1.0	100 10 10 10 10	5 5 5 5 5	360 250 250 250 250
2N3711 2N3721 2N3793 2N3794 2N3825	N N N N	30 18 40 40 30	30 18 20 20 15	6.0 5.0 5.0 5.0 4.0	180-600 20-120 100-600 20	5 10 10 10	1 10 10 2	180-800 60-660 —	5 10 —	1 2 —	 100-600 100-600 200-800	4.5-12 10 10 3.5	10 10 10 10	1.0 	10 10 10 2	5 1 1 2	250 200 250 250 250
2N3828 2N3843A 2N3844A 2N3845A 2N3858	N	40 30 30 30 30	40 30 30 30 30	3.0 4.0 4.0 4.0 4.0	30-200 20-40 35-70 60-120 60-120	20 4.5 4.5 4.5 4.5	12 2 2 2 2	=	===	=======================================	200-500* 60-230 90-250 126-290 90-250	2.5-5 2-4 2-4 2-4 2-4	20 10 10 10 10	=	=	=======================================	300 200 200 200 200
2N3859 2N3860 2N3900 2N3900A 2N3903	N N N N	30 30 18 18 60	30 30 18 18 40	4.0 4.0 5.0 5.0 6.0	100-200 150-300 250-500 250-500 50-150	4.5 4.5 4.5 4.5	2 2 2 2 10	 170-800 170-800 50-200	4.5 4.5 10		90-250 90-250 — — 250	2-4 2-4 4.5-12 4.5-12 4.0	10 10 10 10 5.0		50		200 200 200 200 310
2N3904 2N3905 2N3906 2N3983 2N3984 2N3985	N P N N	60 40 40 30 30 30	40 40 40 12 12 12	6.0 5.0 5.0 3.0 3.0 3.0	100-300 50-150 100-300 30 20 20	1 1 10 10 10	10 10 10 4 4 4	100-400 50-200 100-400	10 10 10 —	1 1 - -	300 200 250 500-1800 400-1800 300-1800	4.0 4.5 4.5 .7-1.6 .7-2.2	5.0 5.0 5.0 10 10	.30 .40 .40 —	50 50 50 —	5 5 1 1	310 310 310 200 200 200
2N4140 2N4141 2N4142 2N4143 2N4227 2N4228	N N P P N P	60 60 60 60 60	30 30 40 40 30 40	5.0 5.0 5.0 5.0 5.0 5.0	40-120 100-300 40-120 100-300 75-150 75-150	10 10 10 10 10	150 150 150 150 150 150				250 250 200 200 250 200	8.0 8.0 8.0 8.0 8.0	10 10 10 10 10	.40 .40 .40 .40 .40	150 150 150 150 150 150	15 15 15 15 15 15	300 300 300 300 300 300

^{*}All devices are in a TO-18 type epoxy package.

GERMANIUM DIODES

GERMANIUM FAST RECOVERY DIODES

CASE 35

TYPE	MIN. F	MINIMUM ORWARD CURRENT (mA)		IAXIMUM F @ Vr		CURRI		REVER IF	SE REC	OVERY VR	LEVEL	LIMIT	LEVEL	LIMIT	
(@ 25°C)	(Volt)	@ +1.0 VOLT	(μ a)	(V)	(μ a)	(V)	(°C)	(mA)	(mA)	(Volts)	(Κ Ω)	nsec	(KΩ)	nsec	REVERSE RECOVERY CIRCUIT
1N60 1N191 1N192 1N276 1N480	30 90 70 100 90	5.0 5.0 40 5.0	25 100	10 10,55°C 10,55°C 50 20,60°C	125 250 100 125	50 50 10 50	55 55 75 60	5 30 30 5 30	1.0	35 35 40 35	50 50 80 50	80 500 500 300 500	400 200 400	3500 3500 3500	Tektronix "S" Unit IBM-Y Ckt IBM-Y Ckt JAN 256 JAN 256
1N490 1N631 1N770	90 90 25	5.0 15mA @ 0.5V	100 20	20,60°C 10	250 120 40	50 60 10	60 40	30 5		35 10	50 15	500 Fwd. F 350	200 Recovery	3500 y @ 50r 700	JAN 256 mA; 100KC <3.5 Volts IBM-Y Ckt
1N777 1N994	70 8	100	25 30	10,55°C 6	125	50	55	30 10		40 6	50 2	500 2	400	3500	IBM-Y Ckt Sampling Scope
1N995 1N996	15	10mA @ .5V 40mA	10	6				10		6	2	6			Sampling Scope
	25	@ .8V 35mA	15	15				5		10	20	300			JAN 256
1N3203	40	@ .5V 20mA	50	25	20	5	55	20		4	16	300			IBM-Y Ckt
1N3467	15	@ .5V	15	10				10		6	1	2			Sampling Scope
1N3468	15	20mA @ .5V	60	10				10		6	1	2			Sampling Scope
1N3592	30	2mA @ .35V 15mA @ .5V	4	4.5	20	20		2	0.2		00	40			Tektronix "S" Unit
1N3666	80	200mA .5-1.0V	10 25	20 50	150	20	70	30		10	20	300			JAN 256
1N3773	25	2mA @ .35V 15mA @ .5V	4	3	20	20		2	0.2		00	40			Tektronix "S" Unit
1N4008	25	10mA @ .5V	100	20	25	12	45	10	1.0		00	70			Tektronix "S" Unit
1N4381	25	2mA .2535V	100	20				2	0.2		∞	100			Tektronix "S" Unit
DR211	75	200	100	50				5		40	50	300			JAN 256
DR362	50	100 20mA	50	20				40		10	20	300			JAN 256
DR401	60	@ .5V 20mA		10,50°C	125	50	50	30		35	50	500	400	2000	IBM-Y Ckt
DR402	60	@ .5V	50	10,50°C	250	50	50	30		35	50	500	200	2000	IBM-Y Ckt
DR403	60	20mA @ .5V	20	10	100	50		5		40	80	300			IBM-Y Ckt
DR404	60	20mA @ .5V	20	10	100	50		5		40	50	300			IBM-Y Ckt
DR407	75	5.0	12	6	20	10	55	5		10	50	500	500	3500	JAN 256
DR408	60	200 10mA	20	10	100	50		5		40	80	300			IBM-Y Ckt
DR419 DR422	25, 55°C	@ .5V 50	20 300	3 50				30 5		5 40	25 50	1000 3000			JAN 256 JAN 256
DR437	75	40mA		4,55°C	50	10	55	30		10	10	500	50	2000	JAN 256
DR459	15	@ .5V 10mA	200	10				5		6	20	200			JAN 256
DR455	40	@ .5V 100	200	20				5		20	50	1000			JAN 256
DR482	60	100	20	40				25		35	40	400			JAN 256
DR498	20	10mA @ .37V	10	10				5		20	40	300			JAN 256
DR500	50	20	12.5	25				5		40	500	500			JAN 256
GD400	15	10mA @ .5V	3	5				10		6	2.0	10			Sampling Scope
GD401	15	10mA	5	5				10		6	2.0	10			Sampling Scope
GD402	45	@ .5V 10mA @ .5V	5	10	15	30		10	2.0		00	80			Tektronix "S" Unit
GD403	35	10mA @ .5V	10	10				10	2.0		∞	80			Tektronix "S" Unit
GD404	35	10mA @ .5V	6	10	10	20		10	2.0		00	60			Tektronix "S" Unit
GD405	35	10mA	10	10	40	20		10	2.0		00	60			Tektronix "S" Unit
GD406	60	@ .5V 10mA @ .5V	5	10	20	30		10	2.0		00	125			Tektronix "S" Unit
GD407	50	10mA @ .5V	10	10	30	30		10	2.0		00	125			Tektronix "S" Unit
GD408	75	10mA @ .5V	6	10	50	50		30		35	50	400			JAN 256
GD409	60	10mA @ .5V	10	10	100	50		30		35	50	400			JAN 256
GD410	135	10mA	30	40	65	40		30		35	50	750			JAN 256
GD411	100	@ .5V 10mA	100	100	100	80		30		35	50	750			JAN 256
40411	100	@ .5V	100	100	100	30		30		33	50	730			JAN 250

ABSOLUTE MAXIMUM RATINGS FOR ALL TYPES

OPERATING TEMPERATURE	-65°C to +90°C	SURGE CURRENT (ONE SEC)	400mA
STORAGE TEMPERATURE	100°C	CONT. POWER DISSIPATION @ 25°C	80mW
LEAD TEMPERATURE 1/6" ± 1/2"	230°C	DERATING FACTOR	10mW/10°C ABOVE 25°C
FROM CASE FOR 10 SECONDS		AVERAGE RECTIFIED CURRENT	50mA (Typ.)

GERMANIUM DIODES

MEDIUM VOLTAGE GERMANIUM DIODES

CASE 35

Lister Billion		MINIMUM		ODES			101 0.
	MIN.	FORWARD CURRENT			REVERSE		
TYPE (@ 25°C)	PIV (Volt)	(mA) @ +1.0 VOLT	IR @ (μa)	VR (V)	IR @ (μa)	VR @ '	(°C)
1N34A	75	5.0	30	10	500	50	1 (0)
1N48 1N51	85 50	4.0 4.0	833 1677	50 50			
1N54 1N54A	85 75	4.0 5.0	150 7	50 10	100	50	
1N56A	50	15	300	30			
1N66 1N69	60 75	5.0 5.0	50 850	10 50	800 50	50 10	
1N69A 1N90	75 75	5.0 5.0	500 800	50 50	30	10	
1N95 1N96	75 75	10 20	800 800	50 50			
1N96A 1N108	75 65	40 50	500 200	50 50			
1N116	75	5.0	100	50			
1N117 1N118	75 75	10 20	100 100	50 50			
1N118A 1N126	75 75	40 5.0	100 50	50 10	850	50	
1N128	50	3.0	10	10			
1N281 1N287	75 60	100 20	30 1500	10 50	500	50	
1N288 1N289	85 85	40 20	350 50	50 50			
1N292 1N294	75 70	100 5.0	200	50 10	800	50	
1N294A 1N295	70 50	5.0	10	10	800	50	
1N298A	85	30mA @ 2.0 Volts	200	10	250	40	50
1N498	60	100	25	40			
1N499 1N500	75 80	100 100	30 40	50 60			
1N632 1N636	90 60	7.0 2.5	20 10	10 10	120	60	
1N772 1N772A	80 80	100 200	50 50	50 50	500 500	80	
1N773	75	100	10	10	100 500	50 75	
1N773A	75	200	10	10	100	50 75	
1N774	70	100	15	10	150 500	50 70	
1N774A	70	200	15	10	150 500	50 70	
1N775	70	100	20	10	250 500	50 70	
1N909	60	10mA 0.35-0.37	10	10			
1N3465 1N3753	60 55	200 150	20 5	45 10			
1N3769	90	25mA @ 0.5 Volts	5	5	20	65	
DR128	60	40	100	50			
DR207 DR213 DR283	75 75 75	20 100 100	50 20	50	2	10	
DR291	60	50	100	25			
DR295	60	1mA @ 0.35 Volts	4	2	50	50	
DR302 DR303	80 60	400 400	100 50	50 50			
DR307 DR308	60 80	200 200	50 10	20 10	50	50	
DR309 DR313	80 80	400 100	10	10 10	50 20	50 50	
DR314 DR317	80 80	100 50	50 50	50 50	20	30	
DR318	60	50	2	10			
DR319 DR323	60 80	50 100	5	10	200	50	75 75
DR324 DR325	80 60	100 100	75	10	500 250	50 50	75
DR326 DR328	60 80	100 300	250 100	50 50			
DR329 DR330	60 80	300 300	50 10	20	50	50	
DR338 DR351	75 50	40 200	100	50	1500	30	50
DR352	50	10mA			300	30	50
DR366	75	@ 0.35 Volts	100	50			
DR385	50	10mA @ 0.37 Volts	10	10			
DR389 DR463	60 85	200 300	50 100	50 10	500	50	

HIGH VOLTAGE GERMANIUM DIODES

CASE 35

			DIOD			-	3E 33
ТҮРЕ	MIN. PIV	MINIMUM FORWARD CURRENT (mA)	IR (CURRE VR @ T	EMP.
(@ 25°C)	(Volt)	@ +1.0 VOLT	(μ a)	(V)	(μ a)	(V)	(°C)
1N34 1N38 1N38A 1N55 1N55A	100 120 120 170 170	8.5 4.0 4.0 3.0 4.0	15 6 6 300 500	10 3 3 100 150	800 500 500 800	50 100 100 150	
1N55B 1N57 1N58 1N58A 1N61	190 100 115 120 140	5.0 3.6 5.0 4.0 5.0	500 300 800 600 300	150 75 100 100 100	700	125	
1N62 1N63 1N67 1N67A 1N68	120 125 100 100 120	5.0 4.0 4.0 4.0 3.0	50 5 5 625	50 5 5 100	50 50	50 50	
1N68A 1N70 1N88 1N89 1N97	130 100 110 100 100	3.0 3.0 2.5 3.5 10	625 25 100 8	100 10 50 5 5	300 100	50 50	
1N98 1N98A 1N99 1N100 1N100A	100 100 100 100 100	20 40 10 20 40	8 8 8 5 5 5	5 5 5 5 5 5 5 5	100 100 100 50 50 50	50 50 50 50 50	
1N102 1N127 1N198	125 125 100	15 3.0 4.0	3 25 10 50 100	25 10 10 50 50	300 250	50 50	75
1N277 1N290 1N291 1N297 1N310 1N313	120 120 120 120 100 130 125	100 5.0 40 3.5 40	75 100 100 10 20 10	10, 75°C 100 100 5 20 20	100 100	50 100	
1N501 1N502 1N633 1N634 1N771	100 120 120 115 100	100 100 125 50 100	40 50 40 45 25	80 100 20 45 50	180 100 500	90 100 100	
1N771A 1N771B DR209 DR272 DR292	100 100 125 150 120	200 400 40 400 4.0	25 25 100 20 200	50 50 100 100 100	500 500	100	
DR301 DR304 DR305 DR306 DR310	100 190 100 100 120	400 200 200 200 100	100 500 100 100 50	50 150 50 50 100			
DR311 DR312 DR315 DR316 DR321	120 100 120 100 100	100 100 50 50 200	100 5 50 100	100 10 100 100	20 125	100	75
DR327 DR336 DR337 DR379	100 120 100 150	300 4.0 40 200	100 8 5	50 5 5	100 50 50	50 50 20	50

LOW VOLTAGE GERMANIUM DIODES

CASE 35

TYPE	MIN. PIV	MINIMUM FORWARD CURRENT (mA)	MAX IR @	VR			CURRENT VR @ TEMP.		
(@ 25°C)	(Volt)	@ +1.0 VOLT	(μ a)	(V)	(µa)	(V)	(°C)		
1N56 1N64 1N107 1N279 1N308	40 20 15 40 10	15 150 100 300	300 100 200 200 500	30 10 10 20 8					
1N309 1N497 1N776	40 30 30	100 100 50	100 20 200	20 20 10	500	30			
1N910	40	10mA 0.35-0.37	10	10					
1N911	30	10mA 0.34-0.37	10	10					
1N3466	40	200	15	30					
1N4502	20, 55°C	3mA 0.3 Volts	10	6	80	6	55		
DR365	20	10mA 0.4 Volts	60	6					
DR427	20	50	500	10					
DR434	30	10mA 0.37 Volts	10	10					
DR435	20	10mA 0.37 Volts	10	10					
DR464	12	50	100	5					

SOLID STATE ASSEMBLIES

General Instrument maintains complete facilities for design fabrication and testing of virtually any type of solid state assembly...and at prices that can save substantial sums for the user who may be faced with a heavy investment to produce these assemblies "in house." You will find examples of GI's capability in the wide range of standard devices shown here.

HIGH VOLTAGE RECTIFIER CARTRIDGES

HIGH TEMPERATURE TYPES



Data Sheet No. RB1163 Type 1N1731A-1N1734A, 1N2382A to 1N2384A PRV 1.5 kV to 10 kV I₀ to 350 mA

GENERAL PURPOSE TYPES



Data Sheet No. RB1152 1—Pigtail 2—Ferrule 3—Fuse Clip Mounting All styles — PRV 1kV to 30 kV I₀ to 350 mA

FAST SWITCHING TYPES



To 50 KC All Styles PRV 1kV to 10 kV I $_{0}$ to 300 mA Consult factory for data sheet.

MINIATURE TYPES



PRV to 10 kV $$I_{0}$$ to 100 mA Consult factory for data sheet.

HIGH VOLTAGE RECTIFIER BLOCKS

GLASS-AMP HV BLOCKS



Featuring Controlled Avalanche Design PRV 1kV to 18 kV

I₀ to 1.0 Amperes Data Sheet No. RB1165

SOLID STATE TUBE REPLACEMENTS

1N1262 4.8 Volt Tube Replacement

1N570/6X4 Tube Replacement





PRV 1500 V @ 75 mA FW PRV 25,000 V @ 500 mA HW
All intermediate types — Data Sheet SPR 3

KILOPOTENTIAL RECTIFIERS

R-C COMPENSATED ASSEMBLIES

Standard Puck Modules

Custom Board Assemblies



PRV 20 to 200 kV I_0 to 150 mA Data Sheet No. RB3002-1 I_0 to 300 mA Data Sheet No. RB3002-2



PRV 20 to 200 kV oil immersed I_0 to 1.0 Amperes Consult Factory for data sheet

GENERAL PURPOSE RECTIFIER ASSEMBLIES

• 1.5 AMP FULL WAVE RECTIFIERS





• 3.0 AMP FULL WAVE RECTIFIERS - STUD TYPE

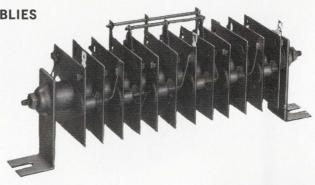




Center Tap & Doubler

• 1.5 AMP TO 9.0 AMP OPEN FIN ASSEMBLIES

All Configurations shown on Data Sheet No. RB1176



CUSTOM SOLID STATE ASSEMBLIES

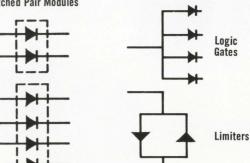
- G. I. offers a complete custom packaging facility including: Custom molding of shell and welded devices

 - Component interconnection by welding and soldering
 - · Specialized test facilities

Zener Diodes & Controlled Forward Diodes

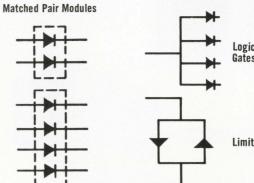


Modulator Bridge & Ring Assemblies









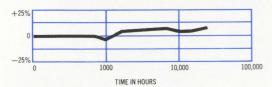
SELENIUM RECTIFIER ASSEMBLIES

TRI-AMP POWER ASSEMBLIES

General Instrument Tri-Amp Selenium Power Rectifier Assemblies are completely unaffected by aging — a unique advantage which brings to the user reliability previously considered unattainable. In addition, they incorporate a true P-N diffused junction and safely withstand large transients.

Standard Power Assemblies use cells manufactured with the Tri-Amp process. As shown in the life test curve, Tri-Amp does not age!

LIFE CURVE PERCENT CHANGE IN FORWARD VOLTAGE DROP



A COMPLETE RANGE OF ASSEMBLIES ARE AVAILABLE FOR EVERY APPLICATION

Typical Units: Three Phase Bridge For Elevator Control Panel. 260 V. AC 3.3 A. DC.





Center Tap Fast Battery Charger using Heat Sink Backing Plate. 26 V. AC 100 A. DC. Fan Cooled.

Single Phase Bridge with Special Edge Protection for unusual moisture and vibration conditions. 26 V. AC 10A. DC.





Single Phase Bridge Typical Cathodic Protection Unit. 26 V. AC 24 A. DC.

Three Phase Bridge Welding Stack 78 V. AC 400 A. DC. Fan Cooled.

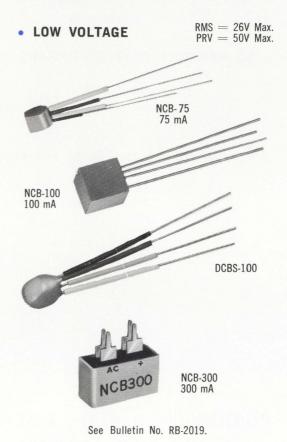


For detailed information, see Tri-Amp Bulletin No. RB2010A.

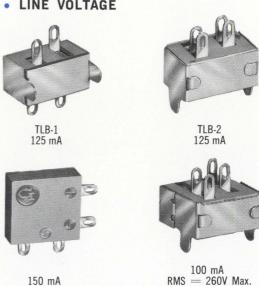
LOW COST MINIATURE **BRIDGE ASSEMBLIES**

Ideal for use in control equipment, AC-DC motors, and small battery chargers. These miniature assemblies are available in bridge, doubler and center-tap

NOTE: All Miniature Bridge Assembly photos are actual size.



LINE VOLTAGE



See Bulletin No. RB2015A

ASSEMBLIES FOR RADIO AND TV APPLICATIONS

RADIO/PHONO





GI65N 65 mA DC

See Bulletin No. RB-2017

COLOR TELEVISION



800 PRV Boost Rectifier



11GA300 300 mA DC



TVC 3 4 Diode Convergence Rectifier

in home entertainment products throughout the world. This "extra" quality is something you get free everytime you specify GI.

General Instrument Selenium Assemblies have accumulated millions of hours of reliable performance

16GA500 500 mA DC

Focus Cartridge



TRANSISTORIZED TELEVISION



High Voltage Rectifier to 30,000 PRV

HIGH VOLTAGE INDUSTRIAL CARTRIDGES



PRV 1 through 25 KV DC Current .4 to 30 mA

See Bulletin No. RB-2002A

LOW COST - LOW VOLTAGE DIODES

An ideal answer to your high volume, mass production requirements where economy as well as dependability are major considerations.



ZIP DIODE

PRV to 50V DC Current to 150 mA

See Bulletin No. RB-2020

CUSTOM MINIATURE ASSEMBLIES



4 Diodes with 1 Common Electrode PRV to 50 V DC Current to 150 mA



ERMS = 26 Max. Idc = 500 mA



 $\begin{array}{c} {\rm ERMS} = 130 {\rm V~Max.} \\ {\rm Idc} = 125 {\rm ~mA} \end{array}$

NUMERICAL INDEX

PRODUCT FAMILY IDENTIFICATION CODES

CAPSIL® Voltage Variable Capacitor Diode Germanium Diode Glass-Amp® Silicon Rectifier Germanium Transistor Glass-Amp® Zener Voltage Regulator Diode CS GD GR Micro Diode Silicon Transistor Epoxy Silicon Transistor
Tube Replacement
Zener Voltage Regulator Diode
Before product identification code indicates
encapsulated assembly or epoxy package. MOS Microcircuit STE Rectifier Bridge (Selenium) Stabistor RB SB SD ZD GT Silicon Diode Silicon Rectifier GZ MC SR

1832 CO	Type No.	Prod. Page Code No.	Type No.	Prod. Page Code No.	Type No.	Prod. Page Code No.	Type No.	Prod. Page Code No.	Type No.	Prod. Page Code No.
1858a	1N34A	GD 17	1N310	GD 17	1N534	SR 6	1N740	ZD 11	1N971	ZD 11
1864	1N38A	GD 17	1N332	SR 8	1N536	SR 6 SR 6	1N742 1N743	ZD 11 ZD 11	1N974	ZD 11
1852 1852	1N54	GD 17	1N335	SR 8	1N539	SR 6	1N745	ZD 11	1N976	ZD 11
1858	1N55	GD 17	1N337	SR 8	1N547	SR 6	1N747	ZD 11	1N978	ZD 11
1867	1N55B	GD 17	1N339 1N340	SR 8 SR 8	1N562	SR 8	1N750	ZD 11	1N981	ZD 11
MSSB	1N57	GD 17	1N342	SR 8	1N570	KSR 18	1N752	ZD 11	1N983	ZD 11
1 1 1 1 1 1 1 1 1 1	1N58A	GD 17	1N344	SR 8 SR 8	1N599A 1N600	KSR 6 KSR 6	1N754 1N755	ZD 11	1N986	ZD 11
Nee	1N62	GD 17	1N347	SR 8	1N601	KSR 6	1N757	ZD 11	1N988	ZD 11
1862 17	1N64	GD 17	1N349 1N440	SR 8 SR 6	1N602	KSR 6 KSR 6	1N761	ZD 11	1N991	ZD 11
NABBA	1N67A	GD 17	1N441	SR 6	1N603A	KSR 6	1N763	ZD 11	1N994	GD 16
NNPO	1N68A	GD 17	1N442	SR 6	1N604A	KSR 6 KSR 6	1N765 1N766	ZD 11 ZD 11	1N1095	SR 6
NBB	1N70	GD 17	1N443B	SR 6	1N606	KSR 6	1N768	ZD 11	1N1100	SR 6
NB66	1N89	GD 17	1N444B	SR 6	1N625	SD 9 SD 9	1N770 1N771	GD 16 GD 17	1N1102 1N1103	SR 6 SR 6
11897	1N96	GD 17 GD 17	1N456	SR 6 SD 8	1N628	SD 9	1N771B	GD 17	1N1105	SR 6
1N99	1N97	GD 17	1N457	SD 8	1N631	GD 16	1N772A 1N773	GD 17 GD 17	1N1262 1N1692	KTR 18 SR 6
1	1N99	GD 17	1N458A	SD 8	1N634	GD 17	1N774	GD 17	1N1694	SR 6
NH107	1N100A	GD 17	1N459A	SD 8	1N643	SD 9	1N775	GD 17	1N1696 1N1697	SR 6 SR 6
	1N107 1N108	GD 17 GD 17	1N461A 1N462	SD 8 SD 8	1N645 1N646	SD 9	1N789	SD 9	1N1732A	KSR 18
1N118A	1N117	GD 17	1N463	SD 8	1N648	SD 9	1N791 1N792	SD 9 SD 9	1N1734A 1N1763	KSR 18 SR 6
1	1N118A 1N126	GD 17 GD 17	1N464 1N464A	SD 8 SD 8	1N658 1N659	SD 9 SD 9	1N794	SD 9	1N2026	SR 8
1N192 GD 16	1N128	GD 17	1N466	KZD 11	1N661	SD 9	1N796	SD 9	1N2028 1N2029	SR 8 SR 8
Name	1N192 1N198	GD 16 GD 17	1N468 1N469	KZD 11 KZD 11	1N663 1N702	SD 9 ZD 11	1N799	SD 9	1N2031	SR 8
1N228	1N226	ZD 11	1N471	KZD 11	1N704	ZD 11	1N801	SD 9	1N2070 1N2071	SR 7 SR 7
1	1N228 1N229	ZD 11 ZD 11	1N473 1N474	KZD 11 KZD 11	1N706 1N707	ZD 11 ZD 11	1N804	SD 9	1N2383A	KSR 18
1N234	1N231	ZD 11	1N480	GD 16	1N709	ZD 11	1N882	SD 9	1N2610	SR 7
1	1N233 1N234	ZD 11 ZD 11	1N482A 1N482B	SD 8 SD 8	1N712	ZD 11	1N885	SD 9	1N2613	SR 7
1N238	1N236	ZD 11	1N483A	SD 8	1N714	ZD 11	1N887	SD 9	1N2615 1N2616	SR 7 SR 7
1N254 SR 8	1N238 1N239	ZD 11 ZD 11	1N484 1N484A	SD 8 SD 8	1N716 1N717	ZD 11 ZD 11	1N889 1N890	SD 9	1N3021	SR 7 ZD 12 ZD 12
1N256	1N254	SR 8	1N485	SD 8	1N719	ZD 11	1N892	SD 9	1N3023 1N3024	ZD 12 ZD 12
1N277 GD 17 1N486B SD 9 1N725 ZD 11 1N954 CS 10 1N3028 ZD 12	1N256 1N270	SR 8 GD 17	1N485B 1N486	SD 8 SD 8	1N721 1N722	ZD 11 ZD 11	1N909 1N910	GD 17	1N3026	ZD 12 ZD 12 ZD 12
1 1 1 1 1 1 1 1 1 1	1N277	GD 17	1N486B	SD 9	1N724	ZD 11	1N954 1N955	CS 10 CS 10	1N3028 1N3029	ZD 12 ZD 12
1N289 GD 17 1N490 GD 16 1N729 ZD 11 1N960 ZD 11 1N3033 ZD 12 1N290 GD 17 1N497 GD 17 1N730 ZD 11 1N961 ZD 11 1N3034 ZD 12 1N291 GD 17 1N498 GD 17 1N731 ZD 11 1N962 ZD 11 1N3035 ZD 12 1N292 GD 17 1N499 GD 17 1N732 ZD 11 1N963 ZD 11 1N3036 ZD 12 1N294 GD 17 1N500 GD 17 1N733 ZD 11 1N964 ZD 11 1N3037 ZD 12 1N294A GD 17 1N501 GD 17 1N734 ZD 11 1N964 ZD 11 1N3037 ZD 12 1N295	1N281 1N287	GD 17 GD 17	1N487A 1N488	SD 9 SD 9	1N726 1N727	ZD 11 ZD 11	1N957 1N958	ZD 11 ZD 11	1N3030 1N3031	ZD 12 ZD 12
1N291 GD 17 1N498 GD 17 1N731 ZD 11 1N962 ZD 11 1N3035 ZD 12 1N292 GD 17 1N499 GD 17 1N732 ZD 11 1N963 ZD 11 1N3036 ZD 12 1N294 GD 17 1N500 GD 17 1N733 ZD 11 1N964 ZD 11 1N3037 ZD 12 1N294A GD 17 1N501 GD 17 1N734 ZD 11 1N965 ZD 11 1N3038 ZD 12 1N295 GD 17 1N502 GD 17 1N735 ZD 11 1N966 ZD 11 1N3039 ZD 12 1N297 GD 17 1N530 SR 6 1N736 ZD 11 1N966 ZD 11 1N30340 ZD 30	1N289	GD 17	1N490	GD 16	1N729	ZD 11	1N960 1N961	ZD 11 ZD 11	1N3033 1N3034	ZD 12 ZD 12
1N294A GD 17 1N501 GD 17 1N734 ZD 11 1N965 ZD 11 1N3038 ZD 12 1N295 GD 17 1N502 GD 17 1N735 ZD 11 1N966 ZD 11 1N3039 ZD 12 1N297 GD 17 1N530 SR 6 1N736 ZD 11 1N967 ZD 11 1N3040 ZD 30 1N297 2D 12	1N291 1N292	GD 17 GD 17	1N498 1N499	GD 17 GD 17	1N731 1N732	ZD 11 ZD 11	1N962 1N963	ZD 11 ZD 11	1N3035 1N3036	7D 12
1N297 GD 17 1N530 SR 6 1N736 ZD 11 1N967 ZD 11 1N3040 ZD 30	1N294A	GD 17	1N501	GD 17	1N734	ZD 11	1N965	ZD 11	1N3038 1N3039	ZD 12 ZD 12
1N298A GD 17 1N531 SR 6 1N737 ZD 11 1N968 ZD 11 1N3041 ZD 12 1N308 GD 17 1N532 SR 6 1N738 ZD 11 1N969 ZD 11 1N3042 ZD 12	1N297 1N298A	GD 17 GD 17	1N530 1N531	SR 6 SR 6	1N736 1N737	ZD 11 ZD 11	1N967 1N968	ZD 11 ZD 11	1N3040 1N3041	ZD 30 ZD 12

	Code	No.	No.	Prod. Page Code No.	Type No.	Prod. Page Code No.	Type No.	Prod. Page Code No.	Type No.	Prod. Code	Page No.
1N3043 1N3044	ZD	12 12	2N444A 2N445A	GT 13 GT 13	2N2905A 2N2906	ST 14 ST 14	DCBS 100J DG100J	KSR 20 GR 7	MEM511 MEM517	MOS	4 4
1N3045 1N3046 1N3047	ZD	12 12 12	2N446A 2N447A 2N464	GT 13 GT 13 GT 13	2N2906A 2N2907 2N2907A	ST 14 ST 14 ST 14	DG100K DG100M DR128	GR 7 GR 7 GD 17	MEM517A MEM517B	MOS	4 4
1N3048 1N3049	ZD	12 12	2N465 2N466	GT 13 GT 13	2N2921 2N2922	STE 15 STE 15	DR207 DR209	GD 17 GD 17	MEM520 MEM550	MOS	4
1N3050 1N3051	ZD ZD	12 12	2N467 2N519A	GT 13 GT 13	2N2923 2N2924	STE 15 STE 15	DR211 DR213	GD 16 GD 17	MEM551 MEM1000	MOS	4
1N3189 1N3190	SR SR	7	2N520A 2N521A	GT 13 GT 13	2N2925 2N2926	STE 15 STE 15	DR272 DR283	GD 17 GD 17	MEM1002 MEM1005	MOS	4
1N3191 1N3203 1N3465		7 16 17	2N522A 2N523A 2N579	GT 13 GT 13 GT 13	2N3015 2N3133 2N3134	ST 14 ST 14 ST 14	DR291 DR292 DR295	GD 17 GD 17	MEM2001 MEM2002	MOS MOS	4 4
1N3466 1N3467	GD	17 16	2N580 2N585	GT 13 GT 13	2N3135 2N3136	ST 14 ST 14	DR301 DR302	GD 17 GD 17 GD 17	MEM2003 MEM2004	MOS MOS	4
1N3468 1N3477	GD ZD	16 11	2N594 2N595	GT 13 GT 13	2N3252 2N3253	ST 14 ST 14	DR303 DR304	GD 17 GD 17	MEM2004A MEM2005	MOS	4
1N3488 1N3592	GD	10 16	2N596 2N597	GT 13 GT 13	2N3390 2N3391	STE 15 STE 15	DR305 DR306	GD 17 GD 17	MEM2006 MEM2007	MOS MOS	4
1N3628 1N3666 1N3753	GD	10 16 17	2N598 2N599 2N600	GT 13 GT 13 GT 13	2N3391A 2N3392	STE 15 STE 15	DR307 DR308	GD 17 GD 17	MEM2008 MEM3020 MEM3021	MOS MOS MOS	4 4 4
1N3769 1N3773	GD	17 16	2N601 2N696	GT 13 GT 13 ST 14	2N3393 2N3394 2N3395	STE 15 STE 15 STE 15	DR309 DR310 DR311	GD 17 GD 17 GD 17	NC8	MC	5
1N3945 1N3946		10 10	2N697 2N698	ST 14 ST 14	2N3396 2N3397	STE 15 STE 15	DR312 DR313	GD 17 GD 17	NC9 NC10 NC11	MC MC	5 5 5
1N3947 1N4008	GD	10 16	2N699 2N706	ST 14 ST 14	2N3398 2N3414	STE 15 STE 15	DR314 DR315	GD 17 GD 17	NC12 NC16	MC MC	5 5
1N4162 1N4163	GZ	12	2N706A 2N706B	ST 14 ST 14	2N3416 2N3563	STE 15 STE 15	DR316 DR317	GD 17 GD 17	NC17 NC101	MC MC	5
1N4164 1N4165 1N4166	GZ	12 12 12	2N708 2N718 2N718A	ST 14 ST 14 ST 14	2N3564 2N3565	STE 15 STE 15	DR318 DR319 DR321	GD 17 GD 17 GD 17	NC511 NC513	MC	5
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1N4169 1N4170	GZ GZ	12 12	2N743 2N744	ST 14 ST 14	2N3607 2N3638	STE 15 STE 15	DR325 DR326	GD 17 GD 17	NCB300 NCS675A PA300	KSR MC SD	20 5 7
1N4171 1N4172	GZ	12 12	2N753 2N759	ST 14 ST 14	2N3638A 2N3641	STE 15 STE 15	DR327 DR328	GD 17 GD 17	PA305 PA310	SR SR	7
1N4173 1N4174 1N4175	GZ	12 12 12	2N759A 2N760 2N760A	ST 14 ST 14 ST 14	2N3643 2N3644	STE 15 STE 15	DR329 DR330	GD 17 GD 17	PA315 PA320	SR SR	7
1N4176 1N4177	GZ	12 12	2N834 2N835	ST 14 ST 14	2N3645 2N3662 2N3663	STE 15 STE 15 STE 15	DR336 DR337 DR338	GD 17 GD 17 GD 17	PA325 PA330 PA340	SR SR SR	7 7 7
1N4178 1N4179	GZ	12 12	2N914 2N929	ST 14 ST 14	2N3691 2N3692	STE 15 STE 15	DR351 DR352	GD 17 GD 17	PA350 PA380	SR SR	7 7
1N4180 1N4181	GZ	12 12	2N929A 2N930	ST 14 ST 14	2N3702 2N3703	STE 15 STE 15	DR362 DR365	GD 16 GD 17	PC8 PC9	MC MC	5
1N4182 1N4183 1N4184	GZ	12	2N930A 2N1131	ST 14 ST 14	2N3704 2N3705	STE 15 STE 15	DR366 DR379	GD 17 GD 17	PC10 PC11	MC MC	5
1N4185 1N4186	GZ	12 12 12	2N1132 2N1306 2N1307	ST 14 GT 13 GT 13	2N3706 2N3707	STE 15 STE 15	DR385 DR389 DR401	GD 17 GD 17 GD 16	PC12 PC13	MC MC	5
1N4187 1N4188	GZ	12 12	2N1310 2N1311	GT 13 GT 13	2N3708 2N3709 2N3710	STE 15 STE 15 STE 15	DR402 DR403	GD 16 GD 16	PC14 PC15	MC MC	5
1N4189 1N4190	GZ GZ	12 12	2N1312 2N1408	GT 13 GT 13	2N3711 2N3721	STE 15 STE 15	DR404 DR407	GD 16 GD 16	PC16 PC17 PC18	MC MC MC	5 5 5
1N4191 1N4192	GZ	12 12	2N1613 2N1711	ST 14 ST 14	2N3793 2N3794	STE 15 STE 15	DR408 DR419	GD 16 GD 16	PC101 PC200	MC MC	5
1N4193 1N4250 1N4251	GZ GR GR	12 7 7	2N1893 2N2192 2N2192A	ST 14 ST 14 ST 14	2N3825 2N3828	STE 15 STE 15	DR422 DR427 DR434	GD 16 GD 17 GD 17	PC201 PC210	MC MC	5
1N4252 1N4253	GR GR	7 7	2N2192B 2N2193	ST 14 ST 14	2N3843A 2N3844A 2N3845A	STE 15 STE 15 STE 15	DR435 DR437	GD 17 GD 17 GD 16	PC212 PC401 PC402	MC MC MC	5 5 5
1N4254 1N4255	GR GR	7 7	2N2193A 2N2193B	ST 14 ST 14	2N3858 2N3859	STE 15 STE 15	DR459 DR463	GD 16 GD 17	PC501 PC502	MC MC	5 5
1N4256 1N4257 1N4381	GR GR	7 7	2N2217 2N2218	ST 14 ST 14	2N3860 2N3900	STE 15 STE 15	DR464 DR481	GD 17 GD 16	PC503 PC504	MC MC	5
1N4383(G100D) 1N4384(G100G)	GR	16 7	2N2218A 2N2219	ST 14 ST 14	2N3900A 2N3903	STE 15	DR482 DR498	GD 16 GD 16	PC511 PC512	MC MC	5
1N4385(G100J) 1N4502	GR GR GD	7 7 17	2N2219A 2N2220 2N2221	ST 14 ST 14 ST 14	2N3904 2N3905 2N3906	STE 15 STE 15 STE 15	DR500 EG100 GD400	GD 16 GR 7	PC513 PC514	MC MC MC	5
1N4585(G100K) 1N4586(G100M)	GR GR	7 7	2N2221A 2N2222	ST 14 ST 14	2N3983 2N3984	STE 15 STE 15	GD400 GD401 GD402	GD 16 GD 16 GD 16	PC521 PC523 PC250	MC MC	5 5
1N5055 1N5056	SR SR	7 7	2N2222A 2N2303	ST 14 ST 14	2N3985 2N4140	STE 15 STE 15	GD403 GD404	GD 16 GD 16	PC251 PT505	MC SR	5
1N5057 1N5058	SR SR	7 7	2N2368 2N2369	ST 14 ST 14	2N4141 2N4142	STE 15 STE 15	GD405 GD406	GD 16 GD 16	PT510 PT515	SR SR	6
11GA300 11GA500 2N315A	KSR	21 21 13	2N2369A 2N2483 2N2484	ST 14 ST 14 ST 14	2N4143 2N4227 2N4228	STE 15 STE 15 STE 15	GD407 GD408	GD 16 GD 16	PT520 PT525	SR SR	6
2N316 2N316A	GT	13 13	2N2501 2N2537	ST 14 ST 14	AG100D AG100G	GR 7 GR 7	GD409 GD410	GD 16 GD 16	PT530 PT540 PT550	SR SR SR	6 6
2N331 2N356	GT GT	13 13	2N2538 2N2539	ST 14 ST 14	AG100J CS7	GR 7 CS 10	GD411 GI65N	GD 16 SD 21	PT560 PT580	SR SR	6
2N356A 2N357A 2N358	GT GT	13 13	2N2540 2N2648	ST 14 GT 13	CS10 CS12	CS 10 CS 10	GP101A GP101B	SD 10 SD 10	S91 S91H	SR SR	6
2N358A 2N377A	GT	13 13	2N2711 2N2712	STE 15	CS15 CS20	CS 10 CS 10	GP102A GP102B	SD 10 SD 10	S92 S92H	SR SR	6
2N388A 2N396A	GT	13 13 13	2N2713 2N2714 2N2715	STE 15 STE 15 STE 15	CS27 CS30 CS33	CS 10 CS 10 CS 10	GP103A GP103B GP104A	SD 10 SD 10 SD 10	S93 S93H	SR SR	6
2N398A 2N404	GT	13 13	2N2716 2N2837	STE 15 ST 14	CS40 CS47	CS 10 CS 10	GP104B GP105A	SD 10 SD 10	TLB1 TLB2 TVC3	RB RB KSR	20 20 21
2N404A 2N438A	GT GT	13 13	2N2838 2N2904	ST 14 ST 14	CS56 CS68	CS 10 CS 10	GP105B KG100F	SD 10 SD 10 SR 7	W005 W02	SR SR	9
2N439A 2N440A		13 13	2N2904A 2N2905	ST 14 ST 14	CS82 CS100	CS 10 CS 10	KG100G KG100H	SR 7 SR 7	W04 W06 XH100	SR SR SD	9 9 10

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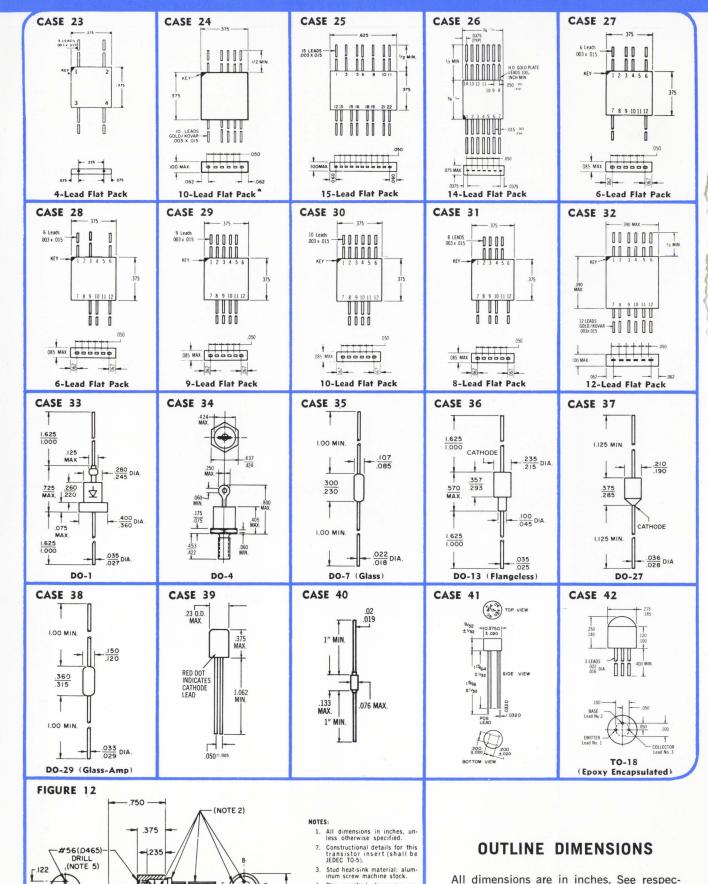
Electronic Component Sales Inc. 2340 W. Main St., Littleton, Colo. 80120 Tel.: (303) 798-8481; TWX: 303-798-8114 Bill Waddell Co.

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GENERAL INSTRUMENT CORPORATION SEMICONDUCTOR PRODUCTS GROUP

CASE DRAWINGS



The specified dimension applies to the maximum permissible protrusion of the transistor (face plane) from the heat-sink inclosure.

Orientation of exhaust hole is not restricted relative to positioning of transistor insert within the stud heat-sink.

C- .395 DIA.

OIOR MAX

.324 -.000 DIA. C'BORE 45° CHAMFER TO .342 DIA

(NOTE 3)

(THREAD LENGTH

-.040 MAX. (NOTE 4)

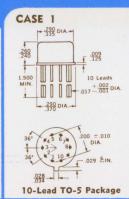
All dimensions are in inches. See respective data sheet for complete outline dimen-

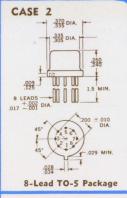
CASE DRAWINGS

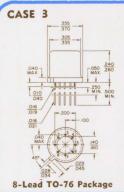


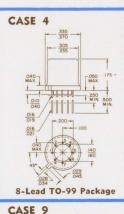
OUTLINE DIMENSIONS

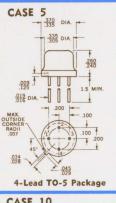
All dimensions are in inches. See respective data sheet for complete outline dimensions and specifications of industrial types.

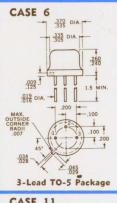


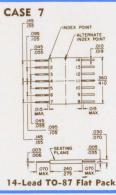


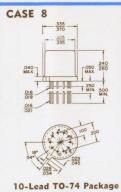


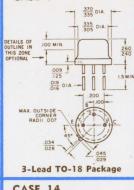


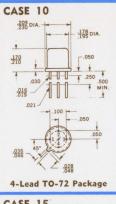


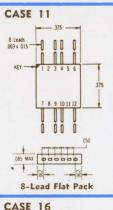


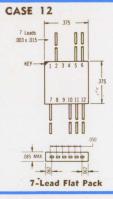


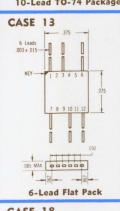


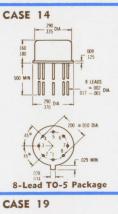


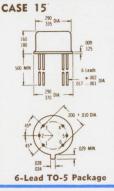


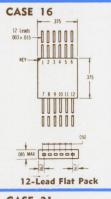


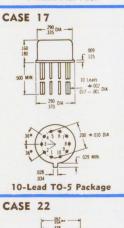


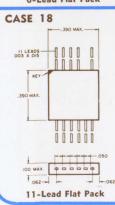


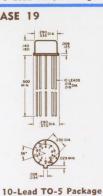


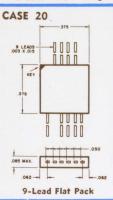


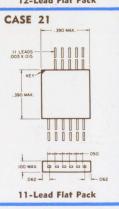


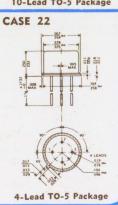












High-Frequency (continued)

	y f					MA	X. RAT	INGS		CHARA	CTERISTI	CS		
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (MHz)	P c (mW)	T _j (°C)	mW/°C	*VCEO *VCBO (V)	I C (mA)	h _{fe} *hFE	lCO *lCEO †lCEX (μA)	C _{oe} *C _{ob} (pF)	Package Outline (TO-)	Remarks
	2N3728 2N3729 2N3733 40281 40307	FA FA RCA RCA RCA	npn,DPE,si npn,DPE,si npn,si npn,si npn,si	400 400 400 *400 *400	1.6 W 1.6 W 23W 11.6W 23W	200 200 200 200 200 200	9.15 9.15 130 660 131	30 30 - 18 40	500 500 3A 1a 3A	*30-280 *30-280 - - *10 (min)	.010 .010 *250 *100 *0.25	- *20 *22 *20	- 60 60 60	Vces=40; overlay type † Iceo Overlay type
HF 78	A466 MM1945 MPS2894 2N834 2N982	AMP MO MO MO SPR	npn,. L,si npn,E,si pnp,EP,si npn,EP,DD,si pnp,MD,ge	*400 *400 *400 *450 *450	150 800 1000 500 60	175 175 125 175 175 100	1.0 5.33 10 2 0.8	*40 *40 12 *40 *20	25 500 - 200 100	*60 *25 *40-150 5 *100	.001 0.5 .08 .01	- *5 *6 *2.8 *1.9	72 18 92 18	Cre=.015 pf SY, TR, GI, FA, NA, SPR, ITT
HF 79	2N983 2N1562 2N2168 2N2169 T1407	SPR MO SPR SPR TI	pnp,MD,ge pnp,DM,ge pnp,MD,ge pnp,MD,ge npn,PL,si	*450 *450 *450 *450 *450	60 3W 60 60 200	100 100 100 100 100 125	0.8 40 0.8 0.8 2	*15 25 *20 *15 12	100 250 100 100 30	*85 9 *100 *85 *20	1 10 1 1 0.5	*1.9 *10 *1.9 *1.9 2.2	18 - 9 9	Plast, IEC, GME
ПГ 79	2N960 2N961 2N962 2N964 2N964A	MO MO MO MO MO	pnp, EM, ge pnp, EM, ge pnp, EM, ge pnp, EM, ge pnp, EM, ge	*460 *460 *460 *460 *460	300 300 300 300 300 300	100 100 100 100 100	4 4 4 4	*15 *12 *12 *15 *15		*40 *40 *40 *70 *80	0.3 .3 - .3 .3	*4 *4 .3 *4 *4	18 18 18 18 18	SY, TI, RCA TI, RCA SY, TI, RCA SY, TI, RCA SY, TI
HF 80	2N965 2N966 2N502 2N700 2N835	MO MO *SPR MO MO	pnp,EM,ge pnp,EM,ge pnp,MD,ge pnp,DM,ge npn,PE,si	*460 *460 500 *500 *500	300 300 60 - 500	100 100 85 100 175	4 4 1 1 2	*12 *12 *20 *25 *25	- 50 50 200	*70 *70 45 4 4.5	0.3 0.3 3 2 0.01	*4 *4 *1.0 1.5 *2.8	18 18 9 17 18	SY, TI, RCA SY, TI, RCA *PH orig Reg
111 00	2N1561 2N2095 2N2098 2N2480A 2N2883	MO SPR SPR - FA	pnp,DM,ge pnp,ED,ge pnp,ED,ge npn,PE,si npn,PE,si	*500 *500 *500 *500 *500	. 3W 1W 1W 2W 1750	100 100 100 200 200	40 13.3 13.3 11.4 10	25 *30 *30 *80 200	250 300 300 500 300	10 - - *35 *30	10 2 2 0.01 0.1	*10 *6.5 *6.5 *20 *1.0	31 9 5	PG=6 d B @ 160 MHz PG=6 d B @ 160 MHz diff amp, MO, TRWS
	2N2884 2N3227 2N3375 2N3553	FA SPR RCA	npn,PE,si npn,PE,si npn,si npn,si	*500 *500 *500 *500	1750 1200 11.6W	200 200 200 200	10 6.85 660	20 *40 40	300 500 1.5A	*30 *30 -	0.1 0.2 100	*1.0 *4 *10	5 18 60	RCA "Overlay" emitter type, MO, VEC RCA "Overlay" emitter type,
HF 81	2N3924 2N3925 2N3926 2N3927	MO MO MO	npn,A*,si npn,A*,si npn,A*,si npn,A*,si	*500 *500 *500 *500	7000 10000 11600 23200	200 200 200 200 200	40 57.1 66.3 132.5	18 18 18 18	500 1000 1500 3000	5 5 5 5	100 100 100 250	*12.5 *12.5 *12.5 *25	39 102 60 60	MO, VEC *Annular *Annular *Annular *Annular
	2N3961 2N4012 40290 40291 40305	MO RCA RCA RCA RCA	npn,si npn,si npn,si npn,si npn,si	*500 *500 *500 *500 *500	10000 11.6W 7W 11.6W 7W	200 200 200 200 200 200	57.2 66 40 66 40	40 - - - 40	1000 1.5A 0.5A 0.5A 1000	5 - - *10 (min)	1000 *0.1 *100 *100 *0.1	*10 *10 *17 *17 *17 *10	102 60 39 60 39	Vces=40; overlay type Vces=90; overlay type Vces=90; overlay type Overlay type
HF 82	MPS3639 MPS3640 40306 A1243 AF139	MO MO RCA AMP SA	pnp,EP,si pnp,EP,si npn,si pnp,MS,ge pnp,MS,ge	*500 *500 *500 *500 *500	500 500 11.6W 50 60	125 125 200 75 90	5 5 66 .9 2.5	6 12 40 20 15	80 80 1.5A 7 10	*30-120 *30-120 *10 (min) *10 *50	- *0.1 8 0.7	*3.5 *3.5 *10 -	92 92 60 18 18	lces=.01 lces=.01 Overlay type uhf-stages
UF 02	AFY39 MM1943 2N869A 2N1195 2N2368	SA MO FA FA	pnp,MS,ge npn,E,si pnp,PE,si pnp,DM,ge npn,PE,si	500 *500 *550 *550 *550	225 600 1200 250 1200	90 175 200 100 200	5.0 4.0 6.85 3.33 6.85	*32 *40 18 *30 15	30 200 200 40.0 500	85 *25 *75 13.0 *40	0.4 0.1 0.00005 2.0 0.1	- *4 *3.0 4.0 *2.5	18 lg 18 18 5 18	vhf antennas MO, TI SPR, MO
HF 83	2N3013 2N3014 2N4072 2N4073 40280	FA FA MO MO RCA	npn,PE,si npn,PE,si npn,AE,si npn,AE,si npn,si	*550 *550 *550 *550 *550	1.2W 1.2W 350 1500 7W	200 200 200 200 200 200	6.85 6.85 2.0 8.57 1.14	15 20 20 20 20 18	- 100 150 500	*60 *60 *10 *10	- 0.1 0.1 *100	*5 *5 *4 *4 *15	52 52 18 5 39	
HF 84	A472 A473 2N709/46 2N709/51 2N769	AMP AMP SY SY *SPR	npn,si npn,si npn,si npn,si pnp,MD,ge	*550 *550 600 600 *600	230 230 400 300 35	175 175 200 200 100	1.54 1.54 - - 0.467	*40 *40 *15 *15 *12	25 25 - - 100	*150 *150 *20-120 *20-120 *55	.001 .001 .005 .005 0.3	- *3.0 *3.0 *1.5	72 72 46 51 18	Cre=.023 pf. Cre=.023 pt. TR TR *PH orig Reg
ПГ 84	2N976 2N2998 2N3049 2N3320 2N3321	SPR TI TI SPR SPR	pnp,MD,ge pnp,ge npn,PE,si pnp,ge pnp,ge	*600 *600 *600 *600 *600	100 75 1.4W 75 75	100 100 200 100 100	1.33 1 9.33 1.0 1.0	*15 *15 *25 10 *12	100 20 100 100 100	*80 20-500 *20 *40 *80	1.0 5 0.01 5 5	*1.5 *1.7 *8 *3 3.5	18 72 - 18 18	*PH, orig Reg Flat Pack, SPR

High-Frequency (continued)

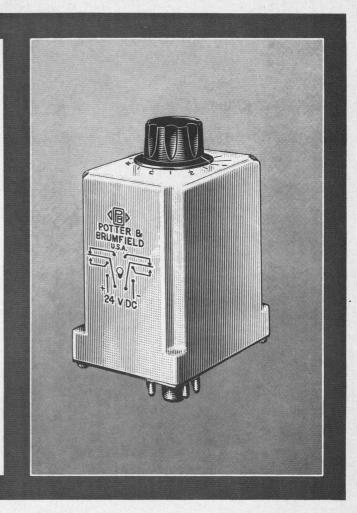
1						MA	X. RATI	NGS		CHARA	CTERISTI	cs		
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (MHz)	P c (mW)	T _j (°C)	mW/°C	*VCEO *VCBO (V)	C (mA)	h _{fe}	*ICEO *ICEX (µA)	C _{oe} *C _{ob} (pF)	Package Outline (TO-)	Remarks
HF 85	2N3322 2N3399 2N3423 2N3424 2N3544	SPR AMP FA FA MO	pnp,ge pnp,MS,ge npn,PE,si npn,PE,si npn,E,si	*600 *600 *600 *600 *600	75 80 1.2W 1.2W 400	100 90 200 200 175	1.0 1.1 3.44 3.44 2.67	*12 *20 15 15 *25	100 7 50 50 100	*25 *10 *20-200 *20-200 *25	5 1 0.010 0.010 0.1	3.5 1.27 1.7 1.7 *2.5	18 18 - - 18	4 lead low Noise AL AL
111 63	2N3683 2N3995 AF139 MM1941 MPS918	KMC TI AMP MO MO	- pnp,ge pnp,MS,ge npn,E,si npn,EP,si	*600 *600 *600 *600 *600	200 300 50 600 500	200 140 75 175 125	1.74 4 .9 4.0 5	*30 *20 *20 *30 15	30 100 7.0 200	*150 150-450 *10 *25 *20	.05 3 12 0.1 .01	*2.0 *4 - *0.5 *1.7	72 39 18 18 92	
HF 86	MP\$3563 2N502A 2N502B 2N2369 2N3303	MO *SPR *SPR FA FA	npn,EP,si pnp,MD,ge pnp,MD,ge npn,PE,si npn,PE,si	*600 620 620 *650 650	500 75 75 1200 3W	125 100 100 200 200	5 1 1 6.85 17	12 *30 *30 15 12	- 50 50 50 1A	*20-200 45 50 *80 *60	.05 3.0 3.0 0.1 100	*1.7 *1.0 *1.0 *2.5 *6.0	92 9 9 18	PH orig Reg PH orig Reg TR, MO, SPR, NUC MO
H 00	D16K1 D16K2 D16K3 2N2369A 2N2708	GE GE GE FA RCA	npn,PL,si npn,PL,si npn,PE,si npn,PE,si npn,EP,si	650 650 *650 *675 *700	200 200 200 1.2W 200	100 100 100 200 200	2.67 2.67 2.67 6.85	30 30 30 15 35	25 25 25 200	*110 *110 *110 *65 180	0.5 0.5 0.5 0.05 0.01	*1.4 *1.4 *1.4 *23 1.5	98 98 98 18	For AGC @ 45 MHz For AGC @ 45 MHz For AGC @ 200 MHz SPR AL
UE 07	2N2962 2N2963 2N3784 2N3785 2N2964	SPR SPR MO MO SPR	pnp,ED,ge pnp,ED,ge pnp,EM,ge pnp,EM,ge pnp,ED,ge	*700 *700 *700 *700 *700	3000 3000 150 150 3000	100 100 100 100 100	40 40 2 2 40	*40 *40 20 12 *30	300 300 20 20 300	- *20-200 *15-200	1.5 1.5 5 5 1.5	7 7 *1 *1 *7	37 37 72 72 72 37	PG=6db@160MHz PG=5db@160MHz PG=6db@160MHz
HF 87	2N2965 2N3304 40404 2N3137 2N3564	SPR FA RCA FA FA	pnp,ED,ge pnp,PE,si npn,EP,si npn,PE,si npn,PE,si	*700 *700 *700 *750 *750	3000 500 300 1000 500	100 200 175 200 125	40 2.0 2 5.71 5.0	*30 6.0 *40 20 15	300 - 500 -	- *63 *25 - 65 *70 *70	1.5 0.010 .025 (ma 12 0.05	*7 *1.9 (x) 4 (ma *2.8 *2.5	37 18 x) 5	PG=5db@160MHz MO CDC, IEC, GME
	\$15657 \$15658 \$15659 2N709 2N709A	FA FA FA FA	npn,DPE,si npn,DPE,si npn,DPE,si npn,PE,si npn,PE,si	750 750 750 *800 *800	200 600 1.0 W 0.5W 500	125 125 200 200 200	5 6 5.71 5	15 15 20 6.0 6.0		- *70 *70 *55 *60		*2.5 - - *2.5 *2.5	- 5 18 18	R0110 package R0110 package SY, AL, TI, RCA, VEC SY, TR, VEC
HF 88	2N709A/46 2N709A/51 2N917 2N3866 2N3783	SY SY FA MO MO	npn,si npn,si npn,DP,si npn,si pnp,EM,ge	800 800 *800 *800 *800	400 400 300 5000 150	200 200 200 200 200 100	- 1.71 28.5 2	*15 *15 15 30 20	- - 400 20	*30-90 *30-90 50 - *20-200	5 .005 0.0005 20 5	*3.0 *3.0 *1.5 *3 *1	46 51 18 39 72	AL, TI, TRWS RCA
	A1220 2N2966 2N3600 40405 2N743/46	AMP PH RCA RCA SY	pnpPADT,ge - npn,PE,si npn,EP,si npn,si	*820 *850 *850 *850 900	90 60 300 300 400	90 100 - 175 200	- .5 - 2 -	25 20 *30 *40 *20	15 100 - 500 200	*20 *15 *20 *20 (min) *20-60	.6 1 0.01 - 10	*1.4 1 1.7 3.5 (n	18 - nax) – 46	Low Noise type UHF amplifier GI, TR
HF 89	2N743/51 2N744/46 2N744/51 2N918 2N2729	SY SY SY FA FA	npn,si npn,si npn,si npn,PE,si npn,PE,si	900 900 900 *900 *900	300 400 300 300 0.8W	200 200 200 200 200 200	- - 1.71 4.56	*20 *20 *20 15 15	200 200 200 50 50	*20-60 *40-120 *40-120 *50 *50	70 10 10 0.0002 0.0001	5 5 *1.4 *2.4	51 46 51 18 46	TR GI, TR TR MO, AL, TI, NUC, TRWS AL
HF 90	2N3478 2N3563 2N3662 2N3663 40238	RCA FA GE GE RCA	npn,PE,si npn,PE,si npn,PEP,si npn,PEP,si npn,PL,si	900 *900 *900 *900 *900	200 500 200 200 180	200 125 100 100 175	5.0 2.67 2.67 1.2	*30 12 *18 *30 *35	- 25 100 50	*25 50 *75 *75 40-170	0.02 0.05 0.5 0.5 0.02 (ma	*2 *1.4 1.2 1.2 x) -	- 98 98 -	CDC, IEC, GME
HF 30	40239 40240 2N700A 2N955 2N2482	RCA RCA MO RCA RCA	npn,PL,si npn,PL,si pnp,DM,ge pnp,MS,ge npn,DM,si	*900 *900 *1000 *1000 *1000	180 180 - 150 150	175 175 100 100 100	1.2 1.2 1 -	*35 *35 *25 *12 *20	50 50 50 150 100	27-100 27-275 4 *30 25-200	0.02 (ma 0.02 (ma 2 5 5		- 17 18 18	
UF 01	2N2784 2N2808 2N2809 2N2810 2N2857	SY RA RA RA RCA	npn,si npn,si npn,si npn,si npn,PE,si	1000 *1000 *1000 *1000 *1000	300 200 200 200 200 300	200 300 300 300 300 200	1.15 1.15 1.15 1.15	15 10 15 10 *30	25 25 25 25 20	40-120 *20 *20 *20 *30-150	.005 .01 .01 .01 0.01	3.0 *0.7 *0.7 *0.7 1.3	† 18 18 18	†TO-18, 46, 51, VEC 4 Leads 4 Leads 4 Leads
HF 91	2N3572 A490 MM2503 MM2550 MM2552	TI AMP MO MO MO	npn, PL, si npn,si pnp,EP,ge pnp,EP,DJ,ge pnp,EP,DJ,ge	*1000 1000 1000 *1000 *1000	200 200 75 300 600	200 200 100 100 100	1.14 1.12 1.0 4 8	13 *30 15 10	50 20 20 100 100	20-300 *70 *20 *20 *30	0.01 .010 10 10	0.85 1.8 *2 *3 *3	72 72 72 18 5	4 lead sim to TO 18

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Time Delay Relays
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Here is a practical cost-saving answer to many timing applications which do not require the extreme precision of much more expensive relays. CH Series solid state time delay relays are quality-built to perform dependably in most industrial applications. Where more critical perameters are required, we recommend our CD Series.

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ACCURACY $\pm 10\%$ —Accuracy is $\pm 10\%$ over the -10° to 55° C temperature range for adjustable time delays. Fixed delays have an accuracy of $\pm 5\%$ at 25° C ambient temperature. Reset time is 100 milliseconds.

INTERNAL RELAY RATED 10 AMPERES—An internally-mounted DPDT relay is rated at 10 amperes, 115 VAC, resistive. Both AC and DC models are available and all come in a white nylon case with octal plug. CH relays for DC operation have an internal protection against damage by reversal of input polarity. Relays will not operate falsely nor be damaged by a transient input voltage having a magnitude up to twice rated input voltage and a duration of eight milliseconds.

rated input voltage and a duration of eight milliseconds.
Write for the complete catalog of P&B Time Delay
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electronic parts distributor.

SPECIFICATIONS

CH and CD Series Comparison

	CH SERIES	CD SERIES
Dial Setting	Reference scale	Time-calibrated ±5% of full scale
Temperature Range	-10°C to +55°C	-40°C to +55°C
Accuracy Over Temperature and Voltage Range	±10% of nominal	±5% of nominal
Transient Protection	Twice rated input voltage for 8 milliseconds	Tested to 1000V— ½ cycle surges (on all 115V AC models)
Inherent False Operation	Contacts may transfer momentarily if timing interval is interrupted	None
Reset Time	100 milliseconds	60 milliseconds
Repeatability	±2%	±1%
Polarity Reversal Protection (on DC)	Yes	Yes



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ON READER-SERVICE CARD CIRCLE 17

High-Frequency (continued)

					MAX. RATINGS CHARACTERISTICS				CS					
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (MHz)	P c (mW).	T _j (°C)	mW/°C	*VCEO *VCBO (V)	1 (mA)	h _{fe} *h	*ICEO *ICEX (µA)	C _{oe} *C _{ob} (pF)	Package Outline (TO-)	Remarks
HF 92	MM2554 2N2929 2N2808A 2N2809A 2N2810A	MO MO RA RA RA	pnp,EP,DJ,ge pnp,EM,ge npn,si npn,si npn,si	*1000 *1100 *1200 *1200 *1200	600 750 200 200 200	100 100 300 300 300 300	8 10 1.15 1.15 1.15	10 10 10 15 10	100 100 25 25 25 25	*30 *10-100 *20 *20 *20	10 5 .01 .01	*3 *2.5 *0.7 *0.7 *0.7	5 5 18 18 18	4 Leads 4 Leads 4 Leads
NF 32	2N3571 2N3880 40235 40236 40237	TI KMC RCA RCA RCA	npn, PL, si 	*1200 *1200 *1200 *1200 *1200	200 200 180 180 180	200 200 175 175 175	1.14 1.74 1.2 1.2 1.2	15 *30 *35 *35 *35	50 30 50 50 50	20-200 *150 40-170 40-275 27-275	0. 01 .01 0.02 (max 0.02 (max 0.02 (max	() -	72 - - ax) -	4 lead sim to TO 18
	2N3633 2N3953 2N3959 2N2999 TIXM104	TR KMC MO TI TI	npn,si npn,si pnp,ge pnp,PL,ge	1300 *1300 *1300 *1400 *1400	300 *200 750 75 40	200 200 200 100 125	1.71 1.74 4.3 1	6 *15 12 *15 *12	50 30 30 20 20	*75 *200 *40-200 15 10-250	0.005 0.1 †.005 5 6	*2.5 *2.0 *2.5 1.7	18 72 18 72 -	
HF 93	2N3570 TIX3024 TIXM101 2N3932 2N3933	TI TI TI RCA RCA	npn,PL,si pnp,PL,ge pnp,PL,ge npn,PE,si npn,PE,si	*1500 *1500 *1500 *1600 *1600	200 75 75 175 175	200 100 100 175 175	1.14 1 1 1.12 1.12	15 *15 *15 30 40	50 50 50 -	20-150 30-300 30-300 40-150 60-200	0. 01 7 7 0.01 0.01	0.75 *3 *3 0.55 0.55	72	4-lead sim to To 18
	2N3960 2N4260 TIXM103 2N4261 2N2480	MO MO TI MO GE	npn,si pnp,AE,si pnp,PL,ge pnp,AE,si npn,PE,si	*1600 *1600 *1800 *2000 2500	750 200 40 200 2W	200 200 125 200 200	4.3 1.14 1 1.14 11.4	12 15 *12 15 *75	30 30 20 30 500	*40-200 *30 - 150 10-250 *30 - 150 *20	†.005 †.005 6 †.005 0.05	*2.5 *2.5 - *2.5 *2.5 *20	18 72 - 72 5	diff amp, MO, SPR, TRWS
HF 94	AFY34 2N144 2N231 2N262 2N374	SA SY *SPR RCA RCA	pnp,EP,MS,ge npn,AL,ge pnp,SBT,ge pnp,ge pnp,DR,ge	3500 - - - -	1000 9 80 80	90 75 55 71 71	6.3 - 0.9 -	*40 *60 *4.5 34 25	20 800 3 - -	10 *10.5 66 - -	500 3 5 8	11111	† 13 24 7 7	† coax *PH orig Reg
	2N656 2N657	TI TI	npn,si npn,si	-	4	200	22.8	60 100	1 1	*30	10 10		-	TRWS, FA, TR, AMP, CDC, STC, SSP TRWS, FA, TR, AMP, CDC, STC, SSP RCA
HF 95	2N706A 2N710 2N715 2N716 2N738	TI TI TI TI	npn,si pnp,ge npn,si npn,si npn,si	1 1 1 1	300 300 500 500 500	175 100 175 175 175	2.0 4.0 3.33 3.33 3.33	20 *15 35 40 80	50 50 100 100 50	2 6 1 *10 20	10 3 1 1	*5 - *6 *6 *10	18 18 18 18 18	FA, SY, MP, TR, GI, ITT, MO SY NA NA TR
17	2N739 2N740 2N743 2N744 2N753	TI TI TI TI	npn,si npn,si npn,si npn,si npn,si	- - - - -	500 500 300 300 300	175 175 175 125 175	3.33 3.33 2 2 2	80 80 12 12 20	50 50 200 200 50	40 80 *20 9 *40	1 1 1 1 0.5	*10 *10 *5 *5 *5	18 18 18 18 18	TR TR, AL FA, SY, GI, TR, ITT FA, SY, MP, TR, GI, ITT, MO FA, SY, MP, TR, GI, ITT, MO
HF 96	2N781 2N782 2N797 2N849/TI430 2N850/TI431	SY SY TI TI	pnp, EP, ge pnp, EP, ge npn, ge npn, si npn, si	- - - -	300 300 150 300 300	100 100 100 175 175	- 2 2 2	*15 *12 7 15 15	200 200 150 50	*25 *20 6 6 6	3 3 1 0.5 0.5	- *4 *5 *5	18 18 18 50 50	AL
	2N851/TI-422 2N852/TI-423 2N929 2N930	TI TI TI TI	npn,si npn,si npn,si npn,si		300 300 300 300	175 175 175 175	2 2 2 2	12 12 45 45	200 200 30 30	9 9 60 150	- 0.01 0.01	*5 *5 *8 *8	50 50 18 18	FA, GI, SPR, AL, TR, MO, UC FA, GI, SPR, AL, TR, NUC, MO, UC
HF 97	2N985 2N998 2N1052 2N1141 2N1141A	TI FA TR TI TI	pnp,ge npn,DP,si npn,PL,si pnp,ge pnp,ge	- - - -	150 1800 600 750 750	100 200 175 100 100	2 10.3 6 10 10	7 60 *200 *35 *35	200 500 200 100 100	*60 *5,000 *20-80 *40 15.6	3 0.01 - 0.7 4	*6 *25 - -	18 18 5 - -	SY, MO AL MO, SY SY
	2N1142 2N1142A 2N1143 2N1143A 2N1247	TI TI TI TI TR	pnp,ge pnp,ge pnp,ge pnp,ge npn,PLE,si	- - - -	750 750 750 750 750 30	100 100 100 100 100 150	10 10 10 10 10 .24	*30 *30 *25 *30 6	100 100 100 100 5	*40 15.6 *40 15.6 *15	0.7 4 0.7 4 .005	- - - - *20	- - - - 5	SY, MO SY SY, MO SY GE
HF 98	2N1507 2N1564 2N1565 2N1566 2N1572	TI TI TI TI TI	npn,si si,npn npn,si npn,si npn,si	- - - - -	600 600 600 600 600	175 175 175 175 175 175	4 4 4 4 4	*60 60 60 60 80	1000 50 50 50 50 50	*100 20 40 80 20	1 1 1 1	*35 *10 *10 *10 *10	5 5 5 5 5	TRWS, CDC TRWS, TR TRWS, TR TRWS, TR TR

High-Frequency (continued)

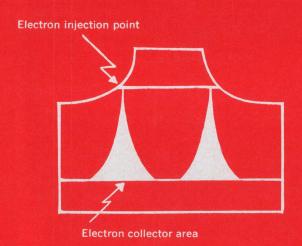
		12.7	(contin			MA	X. RATI	NGS		CHARA	CTERISTI	cs		
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (MHz)	P c (mW)	T _j (°C)	mW/°C	*VCEO *VCBO (V)	1 (mA)	h _{fe} *h	^I CO *ICEO †ICEX (μΑ)	C _{oe} *C _{ob} (pF)	Package Outline (TO-)	Remarks
	2N1573 2N1574 2N1646	TI TI	npn,si npn,si pnp,ge		600 600 150	175 175 100	4 4 2	80 80 *15	5 50 50	40 80 *20	1 1 3	*10 *10 *5	5 5 -	TR TR
HF 99	2N1742 2N1743	*SPR *SPR	-		60 60	125 125	-	*20 *20	_	*33 *33	0.8	-	9	*PH orig. Reg. *PH orig. Reg.
	2N1744 2N1745 2N1754 2N1865 2N1866	*SPR *SPR *SPR *SPR *SPR	pnp,MD,ge pnp,Md,ge pnp,Md,ge	Ē	60 60 50 60 60	125 125 100 100 100	- 0.8 0.8 0.8	*20 *20 *13 *20 *35	- 100 50 50	*33 *33 *20 70 70	1 1.0 1.0 1.0	- *1.5 - -	9999	*PH orig. Reg. *PH orig. Reg. *PH orig Reg, GI *PH orig Reg *PH orig Reg
WE 100	2N1867 2N1868 2N1960 2N1961 2N1990	*SPR *SPR SY SY FA	pnp,MD,ge pnp,MD,ge pnp,ge pnp,EP,ge npn,DD,si	, 1 mail 1	60 60 150 150 2W	100 100 100 100 100 150	0.8 0.8 - - 16	*35 *20 *15 *12 *100	50 50 200 200 1A	50 *33 *25 *20 *30	1.0 1.5 3.0 3.0 1.0	11111	9 9 46 46 5	*PH orig Reg *PH orig Reg TRWS, CDC, SY, GI, AMP, AL, NUC
HF 100	2N2188 2N2189 2N2190 2N2191	TI TI TI	pnp,ge pnp,ge pnp,ge pnp,ge	1.1.1	125 125 125 125 125	85 85 85 85	2.1 2.1 2.1 2.1 2.1	25 25 25 25 25	30 30 30 30	40 60 40 60	3 3 3 3	*2.5 *2.5 *2.5 *2.5		
	2N2192A 2N2360 2N2361 2N2362 2N2389	GE *SPR *SPR *SPR TI	npn,PE,si - - - npn,si	1111	2.8W 60 60 60 450	200 125 125 125 200	16 - - - 2.57	40 *20 *20 *20 *75	1A - - - 500	*100-300 *33 *33 *33 *33 35	0.010 0.8 0.8 1 0.01	*20 - - - *25	5 12 12 12 12 50	CDC, GI, FA, NA, MO, AL RF Amp, *PH orig. Reg. RF mixer, *PH orig. Reg. RF osc, *PH orig. Reg.
HF 101	2N2395 2N2399 2N2398 2N2410 2N2411	TI *SPR *SPR TI TI	npn,si - npn,si pnp,si	= = = = = = = = = = = = = = = = = = = =	450 60 60 800 300	200 125 125 200 200	2.57 - - 4.57 1.72	40 *20 *20 30 20	300 - - 800 100	*20 *33 *33 *30 *20	0.01 .8 0.8 0.3 0.01	*30 - *11 *5	50 12 12 5 18	RF mixer, *PH orig. Reg. RF amp, *PH orig. Reg. FA, NA
HE 100	2N2412 2N2413 2N2415 2N2416 2N2485	TI TI TI TI NA	pnp,si npn,si pnp, ge pnp,ge npn,D,si		300 300 75 75 8700	200 175 100 100 175	1.72 2 1 1 50	20 18 10 10 10	100 200 20 20 20	*40 *30 15 10	0.01 0.1 5 5 1.0	*5 *5 *2 *2 *12	18 18 18 18 5	MO MO VHF Power 5W @ 100MHz
HF 102	2N2486 2N2635 2N2649 2N2650 2N2723	NA TI NA NA SSD	npn,D,si npn,ge npn,D,si npn,D,si n,PL		8700 150 8700 8700 800	175 100 175 175 200	50 2 50 50 4.6	140 12 65 140 60	- 100 - - 40	*45 - - *2000	1.0 5 1.0 1.0 .010	*12 *5 *12 *12 -	5 18 5 5 18	VHF Power 3W @ 200MHz SY, MO 2W @ 130MHz VHF Power 4.5W @ 130MHz Darlington amp, SPR
HE 102	2N2724 2N2725 2N2861 2N2862 2N2863	SSD SSD TI TI TI	n,PL n,PL pnp,si pnp,si npn,si		800 800 300 300 800	200 200 200 200 200 200	4.6 4.6 1.72 1.72 4.57	60 45 20 20 25	40 30 100 100 1000	*7000 *2000 50 25 *30	.010 .002 0.01 0.01 0.5	- *6 *6 *13	18 18 18 18 18	Darlington amp, SPR Darlington amp, SPR
HF 103	2N2864 2N2865 2N2936 2N2937 2N3016	TI TI TI TI BE	npn,si npn,si npn,si npn,si npn,PE,si		800 200 300 300 25000	200 200 175 175 150	4.57 1.14 2 2 420	25 13 55 55 55	1000 50 30 30 2500	*20 20 150 150 *60-150	0.01 0.01 0.01 0.01	*13 *25 *8 *8 *50	5 - - - 5	AL AMP, SPR AMP, GI, SPR SSP
HF 104	2N3017 2N3018 2N3138 2N3139 2N3140	BE BE NA NA NA	npn,PE,si npn,PE,si npn,D,si npn,D,si npn,D,si	11111	25W 25000 20000 20000 20000	150 150 200 200 200	420 420 125 125 125	50 50 65 140 65	5A 10000 2000 200 200 2000	*60-150 *60-150 - - -	0.1 0.1 500 500 500	*50 *50 30 *30 *30	† - 24 24 24	†MT27 Isolated Collector VHF Power 7.5 W © 70 MHz VHF Power 14 W @ 70 MHz VHF Power 4 W @ 130 MHz
ηΓ 104	2N3141 2N3142 2N3143 2N3144 2N3145	NA NA NA NA	npn, D, si npn, D, si npn, D, si npn, D, si npn, D, si		20000 25,000 25,000 25,000 25,000	200 200 200 200 200 200	125 142 142 142 142	140 65 140 65 140	2000 2000 2000 2000 2000 2000		500 500 500 500 500	*30 *30 *30 *30 *30	24 16 16 16 16	VHF Power 8W = 130 MHz VHF Power 5,4 W = 70 MHz VHF Power 8,3 @ 70 MHz VHF Power 4.0W = 130 MHz VHF Power 6.0W = 130 MHz
HE IOT	40080 40081 40082 40242 40243	RCA RCA RCA RCA RCA	npn,si npn,si npn,si npn,PL,si npn,PL,si	11111	500 2W 5W 180 180	175 175 175 175 175	13W/0 330 1.2	30 + 60 + 60 *35 *35	*250 *250 1.5a 50 50	- - *80 *80		- 39 nax) 0.5 nax) 0.5	39 39 - -	†Vcex †Vcex
HF 105	40244 40245 40246 40279 A1170	RCA RCA RCA RCA AL	npn,PL,si npn,PL,si npn,PL,si npn,si npn,DP,si	11111	180 180 180 11.6W 300	175 175 175 200 200	1.2 1.2 0.66	*35 *35 *35 40 10	50 50 50 1.5A	*65 *120 *55 *10 (min) *10	0.02 (m	nax) 0.6 nax) 0.5 nax) 0.6 *10 *3.0		
HF 106	TIXS09 TIXS10 TIX3016A	TI TI TI	npn,EP,si npn,EP,si npn,EP,si		200 200 200	200 200 200	1.14	13 15 15	50 50 50	20-300 20-200 20-200	0.01 0.01 0.01	1.7 1.7 1.7	= =	Ti-line Package Ti-Line Package Ti-Line Package

RCA HOMETAXIAL-BASE MEANS

HOMOGENEOUS-BASE DESIGN IN AXIAL DIRECTION REDUCES RISKS OF SECOND BREAKDOWN...

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NO ELECTRICAL COLLAPSE

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Offer the ultimate in design simplicity for applications from I mA to 30A

TO-5 I _C (Max) TO 1A	T0-66 I _C (Max) TO 4A	TO-3 I _C (Max) TO 15A	TO-3 I _C (Max) TO 30A
$^{40347}_{ m FE}=20-80$ @ $^{\rm I}_{ m C}=450$ mA $^{\rm V}_{ m CEV}$ (Max) $=60{ m V}$	$^{40250}_{ m h_{FE}}=25\text{-}100$ $^{\odot}_{ m C}=1.5\text{A}$ $^{\circ}_{ m CEV}$ (Max) = 50V	40251 h _{FE} = 15-60 @ I _C = 8A V _{CEV} (Max) = 50V	$2N3771 \\ h_{FE} = 15-60 \\ @ I_C = 15A \\ V_{CEO} (sus) (Min) = 40V$
40348 $^{h}_{FE}=30\text{-}100$ $^{@}$ $^{I}_{C}=300$ mA $^{V}_{CEV}$ (Max) $=90V$	2N3054 $h_{FE} = 25-100$ @ $I_{C} = 0.5A$ V_{CEV} (Max) = 90V	$2N3055$ $h_{FE} = 20-70$ @ $I_C = 4A$ $V_{CEV} (Max) = 100V$	$^{2 \text{N} 3772}$ $^{}_{ ext{FE}} = 15\text{-}60$ $^{}_{ ext{C}} = 10\text{A}$ $^{}_{ ext{CEO}}$ (sus) (Min) $= 60\text{V}$
$h_{FE} = 25-100$ @ $I_{C} = 150 \text{ mA}$ $V_{CEV} \text{ (Max)} = 140V$	2N3441 $^{h}_{FE}=20-80$ $^{@}$ $^{I}_{C}=0.5A$ $^{V}_{CEV}$ (Max) = 160V	$2N3442$ $h_{FE} = 20-70$ @ $I_C = 3A$ V_{CEV} (Max) = 160V	$2N3773$ $h_{FE}=15-60$ @ $I_{C}=8A$ V_{CEO} (sus) (Min) = 140V

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Types rated at one watt and higher. In order of increasing power dissipation.

					MAX	RATIN	IGS		СН	ARACTERIST	ICS		
Cross Index Key	Type No.	Mfr.	Туре	P _c (₩)	w/°c	T _j (°C)	V CEO *V CBO (V)	l _c (A)	h _{fe} *hFE	ICO *ICEO †ICEX (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
P1	2N341A 2N709 2N2038 2N2039 2N2040	TR FA TR TR TR	npn,PL,si npn,PE,si npn,PL,si npn,PL,si npn,PL,si	0.25 0.5 .6 0.6 .6	0.003 0.005 .0055 .0055 .0055	175 200 175 175 175	125 6.0 45 75 45	0.15 - .5 .5	*20-80 *55 *12-36 *12-36 *30-90	0.001 0.000005 .015 .015 .015	10000 80000 2,000 2,000 2,000	11 18 5 5 5	ETC SY, TI, TR, VEC ETC ETC ETC
P 2	2N2041 2N957 2N339 2N340 2N341	TR FA TI TI	npn,PL,si npn,DD,si npn,si npn,si npn,si	.6 0.8 1 1	.0055 0.0065 0.008 0.008 0.008	175 150 150 150 150	75 20 55 85 85	.5 - 0.06 0.06 0.06	*30-90 *60 9 9	.015 10 0.001 0.001 0.001	2,000 *250000 - - -	5 18 11 11 11	ETC TRWS, AMP TR, ETC TR TR
ΓZ	2N342 2N342A 2N342B 2N343 2N343A	TI TI TI TI TI	npn,si npn,si npn,si npn,si npn,si	1 1 1 1 1	0.008 0.008 0.008 0.008 0.008	150 150 150 150 150	60 85 85 60	0.06 0.06 0.06 0.06 0.06	9 9 9 28 15	0.001 0.001 0.001 0.001 0.001	1 1 1 1	11 11 11 11 11	TR TR TR TR
	2N343B 2N706	TI FA	npn,si npn,DD,si	1	0.008 0.0067	150 175	65 *25	*0.06	28 *45	0.001 0.000005	400000	11 18	TR ITT,SPR,SY,MO,TR,AMP
	2N707 2N2106	FA GE	npn, DD, si npn, si	1	0.0067	175 200	*56 *60	<u>-</u>	*12 12-36	0.000005	400000 15000	18 5	GI, RCA, NUC TRWS, MO, GI TR
P3	2N2107 2N2108 2N708	GE GE FA	npn,si npn,si npn,DP,si	1 1 1.2	.008 .008 0.0069	200 200 200	*60 *60 15	1 1 -	30-90 75-200 *50	.2 .2 0.000004	15000 15000 400000	5 5 18	TR, TI TR, TI ITT, SY, MO, TR, GI, AMP, NA, RCA, NUC
	2N869	FA	pnp,DP,si	1.2	0.00686	200	18	-	*60	0.000005	*200000	18	MO
P 4	2N914 2N915 2N916 2N947 2N995	FA FA FA FA	npn,PE,si npn,DP,si npn,DP,si npn,DP,si pnp,PE,si	1.2 1.2 1.2 1.2 1.2	0.0069 0.0069 0.0069 0.0069 0.0069	200 200 200 200 200 200	15 50 25 *20 15	- - 0.1 -	*55 *100 *100 *40 *70	0.000004 0.000005 0.000005 10 0.000001	*370000 *300000 *400000 *250000 *150000	18 18 18 18 18	ITT, MO, TR, GI, NUC, SPR NA, MO TRWS, NA, MO TR, MO
	2N996 2N2368 2N2369 2N978 SFT367	FA FA FA NUC	pnp,PE,si npn,PE,si npn,PE,si pnp,DD,si pnp,ge	1.2 1.2 1.2 1.25 1.25	0.00685 0.0685 0.00685 0.010	200 200 200 150 85	12 15 15 20 16	- 0.5 0.5 - 1	*75 *40 *80 *30 *50	0.0002 0.001 0.001 0.001 0.01	*230000 550000 *650000 *60000	18 18 18 18 1	TR, AL, MO, SPR TR, MO, AL, NUC, SPR TR
DE	SFT377 TI159 TI160 TI161 TI162	NUC TI TI TI TI	npn,ge pnp,ge pnp,ge pnp,ge pnp,ge	1.25 1.4 1.4 1.4 1.4		85 100 100 100 100	16 40 60 80 100	0.6 3 3 3 3	*50 *20-60 *20-60 *20-60 *20-60	0.01 .65 .65 .65	- 6 6 6	1	
P 5	2N717	FA	npn, DD, si	1.5	0.010	175	*60	-	*40	0.00001	60000	18	TRWS, CDC, TR, GI, AMP
	2N718	FA	npn, DD, si	1.5	0.010	175	*60	-	*75	1	80	18	TRWS, CDC, SY, MO, TR, GI, AMP, AL, NA
	2N719	FA	npn, DD, si	1.5	0.010	175	*120	-	*40	0.001	60000	18	TRWS, CDC, TR, GI, AMP
D.C.	2N720 2N721 2N722 2N4105	FA FA FA AMP	npn, DD, si pnp, DD, si pnp, DD, si npn, ge	1.5 1.5 1.5 1.6	0.010 0.010 0.010 2.5	175 175 175 90	*120 35 35 *25	- - 1.0	*80 *60 *50 *200	0.001 0.001 0.001 .025	*60000 *90000 *1.0	18 18 18 1	TRWS, CDC, TR, GI, AMP, AL, NA KSC, TR KSC, MO, TR
P6	2N4106 2N718A	AMP FA	pnp,ge npn, DP, si	1.6 1.8	2.5 0.0103	90 200	*25 *75	1.0	*200 *80	.025	*1.0 80000	1 18	CDC, TR, AMP, AL, GI,
	2N719A 2N720A	FA FA	npn, DP, si npn, DP, si	1.8 1.8	0. 0103 0. 0103	200 200	*120 *120	Ξ	*40 *80	0.000005 0.000005	60000 60000	18 18	RCA, NA, MO, TRWS TRWS, CDC, AMP, AL, GI, TR TRWS, CDC, GI, AMP, AL, RCA, TR
	2N870 2N871	FA FA	npn, DP, si npn, DP, si	1.8 1.8	0. 0103 0. 0103	20 0 200	60 60		*75 *130	0.000004 0.000004	80000 100000	18 18	CDC, GI, AMP, AL CDC, GI, AMP, AL,
0.7	2N910	FA	npn,DP,si	1.8	0.0103	200	60	-	140	0.000005	*80000	18	RCA, NA TRWS, CDC, AL
P 7	2N911 2N912 2N696 2N697 2N699	FA FA FA FA	npn,DP,si npn,DP,si npn, DD, si npn, DD, si npn, DD, si	1.8 1.8 2 2 2	0.0103 0.0103 0.0133 0.0133 0.0133	200 200 175 175 175	60 60 *60 *60 *120	11111	70 45 *40 *75 *80	0.000005 0.000005 0.00001 0.00001 0.00001	*70000 *60000 - -	18 18 5 5 5	TRWS, CDC, AL TRWS, CDC, AL TRWS, TR, GI, AMP, CDC, NA TRWS, MO, TR, GI, AMP, CDC, TRWS, SY, TR, GI, AMP, CDC, RCA, NA

					MAX	. RATIN	IGS		СН	ARACTERIS	TICS		
Cross Index Key	Type No.	Mfr.	Туре	P _c (₩)	w/°c	T _j (°C)	V CEO *V CBO (V)	l _c (A)	h _{fe} *h	ICO *ICEO †ICEX (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
	2N1131 2N1132 2N1252 2N1253	FA FA FA FA	pnp,DD,si pnp,DD,si npn,DD,si npn,DD,si	2 2 2 2	0.0133 0.0133 0.0133 0.0133	175 175 175 175 175	35 35 *30 *30	0.6 0.6 -	*30 *45 *35 *45	0.00001 0.00001 0.0001 0.0001	*70000 *90000 *80000 *110000	5 5 5 5	KSC, MO KSC, MO SY, TR, NA NA
P8	2N1420	FA	npn, DD, si	2	0.0133	175	*60	-	*700	0.00001	100000	5	TRWS, CPC, MO, TR, GI, NA, AMP
	2N1837 2N1838 2N1839	TRWS TRWS TRWS	npn,PL,si npn,PL,si npn,PL,si	2 2 2	.013 .013 .013	175 175 175	*80 *45 *45	0.50 0.50 0.50	*40-120 *40-150 *12-50	.0005 .0015 .0015	4500 2300 3500	5 5 5	CDC CDC CDC
D.O.	2N1840 2N1983 2N1984 2N1985 2N1986	TRWS FA FA FA FA	npn,PL,si npn, DD, si npn, DD, si npn, DP, si npn, DD, si	2 2 2 2 2	.013 0.016 0.016 0.016 0.016	175 150 150 150 150	*25 25 25 25 25 25	0.50 - - - -	*10-100 100 80 60 150	0.30 0.001 0.001 0.001 0.001	2000 30000 30000 30000 50000	5 5 5 5 5 5	CDC AMP, ETC, AL AMP, ETC, AL AMP, ETC, AL GI, AMP, ETC, AL
P 9	2N 1987 2N 1988 2N 1989 2N 1990 2N 1991	FA FA FA FA	npn, DD, si npn, DD, Si pnp, DD, si npn, DD, si pnp, DD, si	2 2 2 2 2 2	0. 016 0. 016 0. 016 0. 016 0. 016	150 150 15 0 15 0 150 150	25 45 45 *100 *30	1.0	50 *75 *40 *30 *30	0.001 0.001 0.001 0.001 0.001	50000 50000 50000 	5 5 5 5 5	GI, AMP, ETC, AL GI, ETC, AL STC, ETC, AL SY, GI, AMP, AL KSC, TR, MO
P 10	2N2303 BFY 33 BFY 34 BFY 46 BFY 12	FA SA SA SA SA	pnp, DD, si npn,PL,si npn,PL,si npn,PL,si npn,EP,PL,si	2 2.6 2.6 2.6 2.6	0. 0133 0.016 0.016 0.016 0.016	175 200 200 200 200 200	35 *50 *75 50 40	- 0.5 0.5 0.5 0,5	*90 >35 *40-120 100-300 33-170	0.001 .00002 .00001 .00001 .00002	70000 80000 80000 100,000 180,000	5 5 5 5 5	TR, MO
F 10	2N1335 2N1336 2N1337 2N1338 2N1339	TRWS TRWS TRWS TRWS TRWS	pnp,PL,si npn,PL,si npn,PL,si npn,PL,si npn,PL,si	2.8 2.8 2.8 2.8 2.8	.019 .019 .019 .019 .019	175 175 175 175 175 175	*120 *120 *120 *80 *120	0.30 0.30 0.30 0.30 0.30	*10-150 *10-150 *10-150 *10-150 *10-150	0.001 0.001 0.001 0.001 0.001	-	5 5 5 5 5	
P 11	2N1340 2N1341 2N1342 2N1409 2N1410	TRWS TRWS TRWS TRWS TRWS	npn,PL,si npn,PL,si npn,PL,si npn,PL,si npn,PL,si	2.8 2.8 2.8 2.8 2.8	.019 .019 .019 .0187	175 175 175 175 175 175	*120 *120 *150 *30 *45	0.30 0.30 0.30 0.50 0.50	*10-150 *10-150 *12 *15-45 *30-90	0.001 0.001 0.01 0.010 0.010	- - 5000 2500	5 5 5 5	GI GI
' ''	2N2192A 2N2193A 2N2194A 2N2195A 2N2243A	GE GE GE GE	npn,si npn,PE,si npn,PE,si npn,PE,si npn,PE,si	2.8 2.8 2.8 2.8 2.8	.016 .016 .016 .016 .016	200 200 200 200 200 200	40 50 40 25 80	1 1 1 1 1	100-300 40-120 *20-60 20 *40-120	0.01 1 1 .01 0.1	130000 - 130000	5 5 5 5	CDC, GI, MO, FA, NA, AL CDC, FA, GI, MO, NA, AL CDC, FA, GI, MO, NA, AL CDC, FA, GI, MO, AL CDC
P 12	2N698 2N1206 2N1207 2N1505 2N1506	FA TR TR TRWS TRWS	npn,DP,si npn,PL,si npn,PL,si npn,PL,si npn,PL,si	3 3 3 3	0.0172 .025 .025 .175 .175	200 175 175 175 175 175	60 60 125 *50 *60	- .15 .15 0.5 0.5	*40 *20-80 *20-80 *7-100 *10-100	0.000005 0.001 0.001 .05 .01	- 10,000 10,000 20000 20000	5 5 5 5 5	TRWS, TR, GI, AMP, CDC TI TI NUC NUC STC, RCA, NA
F 12	2N1561 2N1562 2N1613	MO MO FA	pnp,DM,ge pnp,DM,ge npn, DP, si	3 3 3	0.04 0.04 0.0172	100 100 200	25 25 *75	.25 .25	10 9 *80	0.01 0.01 0.0000003	*500 *450 80000	- - 5	TRWS, CDC, MO, TR, GI, AMF AL, RCA
P 13	2N1692 2N1693 2N1711 2N1893A 2N1973	MO MO FA TRWS FA	pnp,DM,ge pnp,DM,ge npn,DT,si npn,PL,si npn,DP,si	3 3 3 3 3	0.04 0.04 0.0172 .017 0.00456	100 100 200 200 200	25 0.04 *75 *140 60	.25 .25 - 0.50	10 9 *130 *40-120 140	0.01 0.01 0.0000003 .0001 0.000005	*500 450 100000 3000 80000	- 5 5 5	TRWS, CDC, MO, TR, GI, AMF GI, TR, NA TRWS, AMP, TR
1 13	2N 1974 2N 1975 2N 2049 2N 3732 2N 1506 A	FA FA FA RCA TRWS	npn,DP,si npn, DP, Si npn, DP, si pnp,DJ,ge npn,PL,si	3 3 3 3.5	0.0172 0.0172 0.0172 0.1 .200	200 200 200 85 200	60 60 *75 *–100 *80	- - 3 0.5	70 45 *130 - *10-100	0.000005 0.000005 0.000004 0.2 .0005	70000 60000 86000 - 20000	5 5 5 5 5	AL, TRWS, AMP, TR TRWS, AMP, TR AL VEC
	SP10800 2N497 2N498 2N656	FA TI TI TI	npn,DP,si npn, TD, si npn, TD, si npn, si	3.5 4 4 4	.200 0. 0228 0. 0228 0.0228	200 200 200 200 200	45 60 100 60	1 1 1	*60-600 *12-36 *12-36 *30	.010 0.01 0.01 0.010	- *20 *20 -	89 5 5 –	Dual npn TRWS TRWS TRWS, FA, TR, AMP, CDC, STC SSP
P 14	2N657 2N1445 2N1943 2N2657 2N2658	TI TI TI SOL SOL	npn,si npn, TD, si npn, TD, si npn,si npn,si	4 4 4 4	0.0228 0.0228 0.0228 .04 .04	200 200 200 200 200 200	100 120 60 *80 *100	- 1 1 5.0 5.0	*30 *20-80 *30-90 *40-120 *40-120	0.010 0.01 0.01 100 .0001	*20 *20 20000 20000	- 5 5 5 5	TRWS, FA, TR, AMP, CDC, STC TI, AMP, SSP TI, AMP, SSP

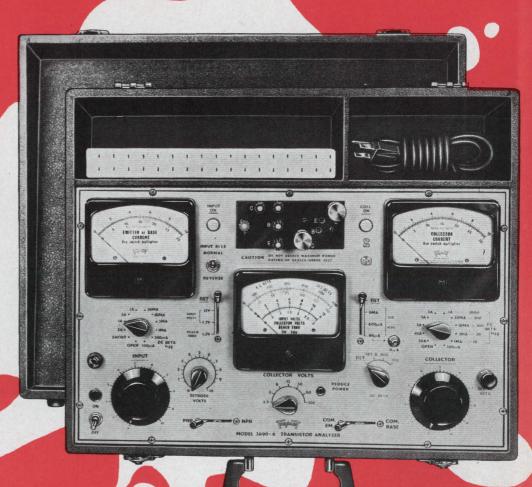
					MAX	RATIN	igs		СНА	RACTERIST	rics		
Cross Index Key	Type No.	Mfr.	Туре	P _c (W)	w/°c	T _j (°C)	*VCEO *VCBO (V)	I _c (A)	h _{fe} *h	ICO *ICEO †ICEX (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
	2N3469 40264 NPC 514 2N497A 2N498A	SOL RCA NUC GE GE	npn,si npn,si npn,si npn,si npn,si	4 4 4 5 5	.04 0.2 -	200 150 - 200 200	35 300 *300 60 100	5 0.1 0.2 1	*100 *60 *30 12-36 12-36	.0001 0.1 0.1 .010	*20,000 *25 - 15,000 15,000	5 - 5 5	SSP, TR, TI TR, SSP, TI
P 15	2N656A 2N657A 2N699B 2N1067 2N1479	GE GE FA - RCA	npn,si npn,si npn, DD, si npn,si npn,si	5 5 5 5 5	.0286 .0286 0.0286 0.33 .0286	200 200 200 175 200	60 100 80 *60 40	1 1 - .5 1.5	30-90 30-90 *80 *15-75 *20-60	.010 .01 0.3 .5	15,000 15,000 - 10 50	5 5 5 8 5	TR, SSP, TI TR, SSP, TI GI, TRWS STC STC, TR
P 16	2N1480 2N1481 2N1482 2N1615 2N1700	RCA RCA RCA TR RCA	npn,si npn,si npn,si npn,PL,si npn	5 5 5 5 5	.0286 .0286 .0286 .045 .0286	200 200 200 175 200	55 40 55 100 40	1.5 1.5 1.5 .2 1	*20-60 *35-100 *35-100 *25 *20-80	.01 .01 .01 .002 .075	50 50 50 2,000 40	5 5 5 5 5	STC, TR STC, TR STC, TR CDC STC, TR, TI
F 10	2N2017 2N2282 2N2283 2N2284 2N2270	GE BE BE BE RCA	npn,si pnp,ge pnp,ge pnp,ge npn,si	5 5 5 5 5	.0285 0.066 0.066 0.066 .0286	200 110 110 110 200	60 30 60 100 45	1 3 3 3 1	*15-200 20 *20 *20 *20 *50-200	0.01 - 100 100 50	- - - - 1000	5 37 37 37 37 5	CDC, TR
D 17	2N2297 2N2350A 2N2351A 2N2352A 2N2353A	FA GE GE GE GE	npn, PE, si npn, PE, si npn, PE, si npn, PE, si npn, PE, si	5 5 5 5 5	0. 0286 .0285 .0285 .0285 .0285	200 200 200 200 200 200	35 25 50 40 25	1.0 1 1 1 1	*50 *20 *40-120 20-60 *20	0.2 0.1 1 1	90000 - - - -	5 46 46 46 46	TR, NA NA NA NA
P 17	2N2364A 2N2726 2N2727 2N2890 2N2891	GE GE GE FA FA	npn,PE,si npn,si npn,si npn,PE,si npn,PE,si	5 5 5 5	.0285 .0266 .0266 0.0286 0.0286	200 200 200 200 200 200	80 *200 *200 80 80	1 1 1 -	*40-120 *30-90 *75-150 55 *80	.0001 .01 .01 0.000002 0.000002	- - *50000 *50000	46 5 5 5 5	TI TI
D.10	2N3016 2N3056 2N3056A 2N3057 2N3057A	BE FA FA FA	npn,DPE,si npn,DPE,si npn,DPE,si npn,DPE,si	5 5 5 5	- .286 .286 .286 .286	200 200 200 200 200	*100 *100 *140 *100 *140	2.5 1 1 1	*60-150 *120 *120 *300 *300	0.001 .010 .010 .010 .010	- 80,000 200 MHz 100 MHz 200 MHz	5 46 46 46 46	
P 18	2N3114 2N3374 2N3439 2N3440 2N3660	FA VEC RCA RCA TR	npn,DP,si npn,PE,si npn,si npn,si pnp,si	5 5 5 5	0.0286 .286 0.33 0.33 0.028	200 200 200 200 200 200	150 80 350 250 30	- .5 1 2	*60 2.9 *40-160 *40-160 50	0.3 .00001 *0.02 *0.05 0.00001	*54000 30Mc	5 5 5 5 5	MO, TRWS
D 10	2N3661 2N3665 2N3665 2N3666 2N3699	TR TR FA FA MO	pnp,si npn,si npn,DPE,si npn,DPE,si pnp, AE, si	5 5 5 5 5	0.028 0.028 .0286 .0286 0.0286	200 200 200 200 200 200	50 80 *120 *120 60	2 1 1 1 3	50 *80 *120 *300 *35-150	0.00001 0.00005 150 150 0.001	30Mc 60Mc 60,000 60,000 *60 MHz	5 5 5 5 5	
P 19	2N3731 2N3916 40309 40311 40314	RCA FA RCA RCA RCA	pnp,DJ,ge npn,DP,si npn,si npn,si npn,si	5 5 5 5	0.16 .040 0.028 0.028 0.028	85 150 200 200 200 200	*-320 150 18 30 40	10 10 0.7 0.7 0.7	*150 *70-350 *70-350 *70-350	0.2 - 250 250 250	50,000 *100 MHz *100 MHz *100 MHz	3 5 5 5 5	
D 20	40315 40317 40319 40320 40321	RCA RCA RCA RCA RCA	npn, si npn, si pnp, si npn, si npn, si	5 5 5 5 5	0.028 0.028 0.028 0.028 0.028 0.028	200 200 200 200 200 200	35 40 40 40	0.7 0.7 -0.7 0.7 1	*70 - 350 *40 - 200 *35 - 200 *40 - 200 *25 - 200	250 250 250 250 250 0.1	*100 MHz - *100 MHz - -	5 5 5 5 5	Vcer = 300
P 20	40323 40326 40327 40347 40348	RCA RCA RCA RCA RCA	npn, si npn, si npn, si npn, si npn, si	5 5 5 5 5	0. 028 0.028 0.028 0.028 0.028 0.028	200 200 200 200 200 200	18 40 - 40 65	0.7 0.7 1 1	*70-350 *40-200 *40-250 *20-80 *30-100	250 250 0.005 0.001 0.001	*100 MHz - - - - -	5 5 5 5 5	Icer = 300
200	40360 40361 40362 40367 PT3500	RCA RCA RCA RCA TRWS	npn, si npn, si pnp, si npn, si	5 5 5 5 5	0.028 0.028 0.028 0.028 0.028	200 200 200 200 200 200	70 70 -70 55 40	0.7 0.7 -0.7 1.5 0.5	*40 - 200 *70 - 350 *35 - 200 *35 - 100 10-80	0.001 - 0.004 0.1	*100 MHz *100 MHz *100 MHz - -	5 5 5 5 39	
P 21	40250VI 40375 2N3719 2N3720 0C30	RCA RCA MO MO AMP	npn,si npn,si pnp,AE,si pnp,AE,si pnp,PADT,ge	5.8 5.8 6 6 6.7	0.033 0.033 .034 .034	200 200 200 200 200 75	40 50 40 60 *16	4 10(peak 3 3 1.4	*25-100) *50-200 *25-180 *25-180 *36	1 *5 .01 .01	*1000 *60 MHz *60000 *60000	66 66 5 5	free air heat radiator free air heat radiator Special AF Power

				MAX. RATINGS CHARACTERISTICS				rics					
Cross Index Key	Type No.	Mfr.	Туре	P _c (W)	w/°c	T _j (°C)	VCEO *VCBO (V)	I _c (A)	h _{fe} *hFE	ICO *ICEO †ICEX (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
P 22	2N326 2N1183 2N1183A 2N1183B 2N1184	SY RCA RCA RCA RCA	npn,AL,ge pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge	7 7.5 7.5 7.5 7.5 7.5	0.1 0.1 0.1 0.1	85 100 100 100 100	*35 20 30 40 20	2 3 3 3 3	*15-60 *20-60 *20-60 *20-60 *40-120	.5 .25 .25 .25 .25	0.15 10 10 10 10	3 8 8 8	
F 22	2N1184A 2N1184B 2N4077 2N4078 2N122	RCA RCA AMP AMP TI	pnp,si pnp,ge npn,ge pnp,ge npn,si	7.5 7.5 7.5 8.0 8.75	0.1 0.1 0.12 0.13 0.07	100 100 90 90 150	30 40 *32 *32 *120	3 3 1.0 1.0 0.14	*40-120 *40-120 *150 *150 *3	.25 .25 .025 .018 0.01	10 10 *1.0 *1.0	8 8	
P 23	2N2631 2N2881 2N2882 2N2911 V-600	RCA STC STC STC VEC	npn,si pnp pnp npn npn,PE,si	8.75 8.75 8.75 8.75 8.75 8.75	.05 .05 .05 .05	200 200 200 200 200 200	60 60 100 125 60	1.5 2 2 3 1.5	*50-250 *20-60 *20-60 *20-60	0,0001 - - - .000005	1500 - - - -	39 5 5 5	VEC, TI CT CT
F 23	V-601 V-602 2N1068 2N1714 2N1715	VEC VEC TI TI	npn,PE,si npn,PE,si npn,si npn,si npn,si	8.75 8.75 10 10 10	.050 .050 .067 0.134 0.134	200 200 175 175 175	60 40 *60 60 100	1.5 1.5 1.5 1	- *15-75 *20 *20	.001 .001 .5 1	- 10 -	5 5 8 -	STC, KSC SSP AMP, BE, SSP
P 24	2N1716 2N1717 2N1718 2N1719 2N1720	H H H	npn,si npn,si npn,si npn,si npn,si	10 10 10 10 10	0.134 0.134 0.134 0.134 0.134	175 175 175 175 175 175	60 100 60 100 60	1 1 1 1 1	* 40 * 40 * 20 * 20 * 40	1 1 1 1	11111	1 1 1 1	SSP SSP SSP SSP SSP
F 24	2N1721 2N2017 2N2067 2N2067B 2N2067G	TI BE ITT ITT ITT	npn,si - pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	10 10 10 10 10	0.134 - - - -	175 - 100 100 100	100 *100 *40 *40 *40 *40	1 5. 3.0 3.0 3.0	*40 *30 - - -	1	- 7 7 7	- † † †	SSP †MT-27, TI †MS7, KSC †MS7, KSC †MS7, KSC
P 25	2N2067-0 2N2067W 2N2068 2N2068-0 2N2068G	ITT ITT ITT ITT	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	10 10 10 10 10	11111	100 100 100 100 100	*40 *40 *80 *80 *80	3.0 3.0 3.0 3.0 3.0	11111	11111	7 7 7 7	† † †	†MS7, KSC †MS7, KSC †MS7, KSC †MS7, KSC †MS7, KSC
F 23	2N3418 2N3419 2N3420 2N3421 2N3730	TI TI TI TI RCA	npn, EP, si npn, EP, si npn, EP, si npn, EP, si pnp, DJ, ge	10 10 10 10 10	0.133 0.133 0.133 0.133 0.33	175 175 175 175 175 85	60 80 60 80 *200	5 5 5 -3A	*20-60 *20-60 *40-120 *40-120	0. 00003 0. 00003 0. 00003 0. 00003 0.2	*40 *40 *40 *40	5 5 5 5 3	
P 26	2N4041 40256 40255 TIP14 2N301	TRWS RCA RCA TI RCA	npn,si npn,si npn,EP,si pnp,AJ,ge	10 10 10 10 10	0.06 0,066 0,066 .133	200 200 200 150 85	40 350 250 60 *40	0.5 1 1 1 3	10-80 *40-60 *40-160 *30-150 *70	0.2 *0.05 *20 .05	- - - 10,000	- 5 - 3	MT59 package Tab-Pac DE, KSC, BE, ITT, LAN
1 20	2N301A VX - 3375 2N3212 2N3213 2N3214	RCA VEC DE DE DE	pnp,AJ,ge npn,PE,si ge pnp,AD,ge pnp,AD,ge	11 11.6 12 12 12 12	- 7 7 7	85 200 110 110 110	60 40 80 60 40	3 1.5 5 5 5	*70 - *30-90 30-90 *30-90	3 *0.1 1 1	*600,000 30 30 30	3 - 37 37 37 37	DE, KSC, BE, ITT
P 27	2N3215 2N2147 2N2148 40022 40050	DE RCA RCA RCA RCA	pnp, AD, ge pnp, DR, ge pnp, DR, ge pnp, AJ, ge pnp, AD, ge	12 12. 5 12. 5 12. 5 12. 5 12. 5	7 - 0.66 0.66	110 100 100 100 100	30 *60 *75 *32 *40	5 5 5 5	*30-90 *100 *100 *70 90	1 1 1 1 max. 0.5	30 4000 3000 *300 500	37 3 3 3	LAN LAN
1. 21	40051 40254 2N1709 2N1710 2N2196	RCA RCA TRWS TRWS GE	pnp,AD,ge pnp,AJ,ge npn,PL,si npn,PL,si npn,si	12.5 12.5 15 15 15	0.66 0.66 0.1 0.1 .0667	100 100 175 175 200	*50 *32 *75 *60 *80	5 5 2.0 2	90 *70 *7.5-75 *7.5-75 *30-90	max. 0.5 3 0.01 0.05 .075	500 *300 2000 1600	3 8 8	NUC NUC Special Heat Sink
D.o.	2N2197 2N2201 2N2202 2N2202 2N2203 2N2204	GE GE GE GE	npn,si npn,si npn,si npn,si npn,si	15 15 15 15 15	66.7 .067 .067 .067	175 175 175 175 175 175	*80 100 100 100 100	1 1 1 1	*200 *30-90 30-90 30-90 30-90		15000 15000 15000 15000	1111	
P 28	2N2239 2N2611 2N2781 2N2782 2N2783	GE GE TRWS TRWS TRWS	npn,si npn,si npn,PL,si npn,PL,si npn,PL,si	15 15 15 15 15	.120 .067 0.1 0.1 0.1	200 175 175 175 175 175	*60 100 *75 *100 *100	1 1 2 2 2 2	*30-200 12-36 *7.5-75 *7.5-75 *7.5-75	10 .05 0.50 0.50 0.01	15000 1870 1870 1870	5 - 8 8 8	Special Heat Sink

					MA)	C. RATIN	IGS		СН	ARACTERIS	TICS		
Cross Index Key	Type No.	Mfr.	Туре	P _c (₩)	w/°c	T _j (°C)	YCEO *VCBO (V)	I _c (A)	h _{fe} *h	ICO *ICEO †ICEX (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
D 00	2N2874 2N2987 2N2988 2N2989 2N2990	TRWS TI TI TI TI	npn,PL,si npn,P,si npn,P,si npn,P,si npn,P,si	15 15 15 15 15	0.1 0.15 0.15 0.15 0.15	175 200 200 200 200 200	*75 80 100 80 100	2. 1 1 1 1	*7.5-75 *25-75 *25-75 *60-120 *60-120	0.01 0.000025 .000025 0.000025 .000025	1870 *30 *30 *30 *30	8 5 5 5 5	
P 29	2N2991 2N2992 2N2993 2N2994 2N2995	TI TI TI TI GE	npn, P, si npn, P, si npn, P, si npn, P, si npn, si	15 15 15 15 15	0. 15 0. 15 0. 15 0. 15 0.15 0.0667	200 200 200 200 200 175	80 100 80 100 100	1 1 1 1 1	*25-75 *25-75 *60-120 *60-120 *90	. 000025 . 000025 . 000025 0.000025 0.01	*30 *30 *30 *30	## ## ## 1	††MT 13 ††MT 13 ††MT 13 ††MT 13
D 20	2N3919 2N3920 2N4000 2N4001 BD109	FA FA TI TI SA	npn,DPE,si npn,DPE,si npn,EP,si npn,EP,si npn,PE,si	15 15 15 15 15	.200 .200 0.15 0.15 0.15	150 150 200 200 200 175	*120 *120 80 100 40	10 10 1 1 1 2	120 300 30-120 40-120 20120	- 0.002 0,002 0.0001	80,000 80,000 40,000 40,000 50,000	3 5 5	SOT — 9 package
P 30	2N2525 2N2835 2N4040 V-610 V-611	TRWS AMP TRWS VEC VEC	npn,PL,si pnp,AJ,ge - npn,PE,si npn,PE,si	16 16 17.5 17.5 17.5	.091 0.25 0.1 .100 .100	200 90 200 200 200 200	*100 32 40 60 60	1 1.0 2.5 2.5	*>10 *30 10-80 -	- .2 .000005 .001	10000 10 - - -	- - - - -	Special MT59 package
P 31	V-612 2N156 2N158 2N158A 2N1042	VEC KSC KSC KSC TI	npn,PE,si pnp,ge pnp,ge pnp,ge pnp,ge	17.5 20 20 20 20 20	.100 .333 .333 .333 0.267	200 100 100 100 100	40 *30 *60 *80 *40	2.5 3 3 3.5	- *25 *21 *21 *20	.001 1.0 1.0 1.0 0.125	4.0 4.0 4.0 -	13 13 13 13	SY, KSC, BE
F 31	2N 1043 2N 1044 2N 1045 2N 2552 2N 2553	TI TI TI TI TI	pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge	20 20 20 20 20 20	0.267 0.267 0.267 0.267 0.267	100 100 100 100 100	*60 *80 *100 *40 *60	3.5 3.5 3.5 3	*20 *20 *20 18 18	0.125 0.125 0.125 0.125 0.125 0.125	11111	11111	SY, KSC, BE *SY, KSC, BE KSC, BE KSC, BE BE
D 20	2N2554 2N2555 2N2556 2N2557 2N2558	TI TI TI TI TI	pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge	20 20 20 20 20 20	0.267 0.267 0.267 0.267 0.267	100 100 100 100 100	*80 *100 *40 *60 *80	3 3 3 3	18 18 18 18 18	0.125 0.125 0.125 0.125 0.125 0.125	11111	11111	KSC, BE KSC, BE KSC, SY, BE KSC, SY, BE KSC, SY, BE
P 32	2N2559 2N2560 2N2561 2N2562 2N2563	TI TI TI TI	pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge	20 20 20 20 20 20	0.267 0.267 0.267 0.267 0.267	100 100 100 100 100	*100 *40 *60 *80 *100	3 3.5 3.5 3.5 3.5	18 25 25 25 25 25	0.125 0.125 0.125 0.125 0.125 0.125	11111	11111	KSC, SY, BE KSC, BE, NA KSC, BE KSC, BE KSC, BE
D 22	2N2697 2N2698 2N2875 2N3738 2N3739	SOL SOL TR MO MO	npn, si npn, si pnp,PLE,si npn,si npn,si	20 20 20 20 20 20	0. 2 0. 2 .14 .133 .133	200 200 175 175 175	*80 *100 50 225 300	5. 0 5. 0 2 .250 .250	*40-120 *40-120 *15-60 *40-120 *40-120	.0001 .0001 .001 0.1 0.1	20000 20000 - *15000 *15000	- - 66 66	
P 33	2N3766 2N3767 2N3917 KM7007 KM7008	MO MO FA KSC KSC	npn,si npn,si npn,DPE,si pnp,AJ,ge pnp,AJ,ge	20 20 20 20 20 20	.133 .133 5 -	175 175 150 100 100	60 80 40 30 60	1 1 10 3.0 3.0	*40-160 *40-160 10 -	0.1 0.1 .00001 -	*15000 *15000 *2500 6 6	66 66 3 † †	†MS-7 † MS-7
D 24	KM7009 KM7010 2N234A 2N235A 2N235B	KSC KSC BE BE BE	pnp, AJ, ge pnp, AJ, ge pnp, ge pnp, ge pnp, ge	20 20 25 25 25 25	- 0.5 0.5 0.5	100 100 90 90 90	80 100 25 *50 *50	3.0 3.0 3 3	11111	7	6	† † 3 3 3	†MS-7 †MS-7 KSC KSC, ITT
P 34	2N285A 2N285B 2N399 2N401 2N418	BE BE BE BE BE	ge,PNP pnp,ge - -	25 25 25 25 25 25	0.5 0.5 - - -	95 95 - - -	1 - 1 - 1 - 1	3 3 3 5	*34-40 31-36 *40	- - -	-	3 3 3 3	KSC KSC KSC, ITT
D 25	2N419 2N420 2N420A 2N1218 2N1483	BE BE BE SY RCA	- npn,AL,ge npn,si	25 25 25 25 25 25	- - - - .143	- - 100 200	- - *45 40	3 5 5 3 3	35 *40 *40 *40-160 *20-60	- - - 3 .015	- - 7 40	3 3 3 8	KSC ITT STC
P 35	2N1484 2N1485 2N1486 2N2308 2N2887	RCA RCA RCA STC TRWS	npn,si npn,si npn,si npn npn,PL,si	25 25 25 25 25 25	.143 .143 .143 .143 .143	200 200 200 200 200 200	55 40 55 80 *100	3 3 3 1.2	*20-60 *35-100 35-100 *20-60 *15-80	.015 .015 .015 .250	40 40 40 - 5000	8 8 8 8	STC STC STC STC MO



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1 READS LEAKAGE CURRENT DOWN TO 100 nanoamperes on 6ua suspension meter

Analyzes both power and signal types at specified voltages and currents.

Continuously adjustable current — up to 30 amp collector. Voltage control for transistor supply electrodes.

Great flexibility allows plotting of transistor characteristic curves along with setting up nearly any type of transistor test. Input bias reversing switch gives added versatility.

TESTS: DC Beta Test • AC Beta Test • ICEO Leakage Test • ICO Leakage Test • IEO Leakage Test • Zener Diode Test • Punch Through Test • Saturation Test • Floating Potential Test • Alpha Test • Diode and Rectifier Tests • SCR Tests

RANGES

Input Current (Emitter or Base): Collector

iceo, ico (icho):

Collector Voltage:

Emitter or Base Voltage: Tetrode:

MODEL 3490-A

0-100-300 ua, 0-1-3-10-30 Ma, 0-1-3-1-3 Amp. 0-300 ua, 0-1-3-10-30 Ma, 0-1-3-10-30 Ma, 0-1-3-10-30 Ma, 0-60 Ma, 0-60 ua, 0-60 ua, 0-60 ua, 0-60 ua, 0-120 V 0-60 V

ua. 0-120 V, 0-60 V, 0-30 V, 0-12 V, 0-6 V, 0-3 V, 0-1.2 V.

0-12 V, 0-1.2 V. 0-10 V Calibrat-

ed Control.
Shipping wt:
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Suggested
U.S.A. User Net
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TRIPLETT ELECTRICAL INSTRUMENT COMPANY, BLUFFTON, OHIO

					MA	(. RATIN	NGS		СНА	RACTERIS	TICS	100	
Cross Index Key	Type No.	Mfr.	Туре	P _c (₩)	w/°c	T _j (°C)	VCEO *VCBO (V)	I _c (A)	hfe *hFE	ICO *ICEO †ICEX (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
	2N3018 2N3021 2N3022 2N3023 2N3024	BE MO MO MO	pnp,AE,si pnp,AE,si pnp,AE,si pnp,AE,si pnp,AE,si	25 25 25 25 25 25	1.67 1.67 1.67 1.67	175 175 175 175 175	*100 30 45 60 30	10 3 3 3 3	*40 *20-60 *20-60 *20-60 *50-180	-	100,000 100,000 100,000 100,000	* 3 3 3 3 3	*MT10A
P 36	2N3025 2N3026 2N3230 2N3231	MO MO RCA RCA	pnp,AE,si pnp,AE,si npn,si	25 25 25 25	1.67 1.67 0.143	175 175 200 200	45 60 60 80	3 3 7 7	*50-180 *50-180 *2,000 - 20,000 *2,000 - 20,000	- 0.1 0.1	100,000 100,000 -	3 3 -	Darlington Type, TI Darlington Type, TI
	2N3441 2N3740 2N3741 2N3836	RCA MO MO TI	npn, si pnp,si pnp,si npn,EP,si	25 25 25 25 25	0.143 .143 .143 .143	200 200 200 200 200	140 60 80 60	3 1 1 7	*20-80 *30-100 *30-100 *2 K-20 K	5 0.1 0.1 0.01	*4000 *4000 40,000	66 66 66	Darlington
P 37	2N3837 40368 PT5694 TI156 TI158	TI RCA TRWS TI TI	npn,EP,si npn,si - pnp,ge pnp,ge	25 25 25 25 25 25	.143 0.143 .143 .33 .33	200 200 200 100 100	80 55 40 30 60	7 3 2.0 3 3	*2 K-20 K *35 - 100 10-80 *25-75 *25-75	0.01 0.009 2.0 .65	40,000 - 3.0 6 6	- 8 - -	Darlington MT59 package
	T1539 T1540 V - 800 2N1755 2N1756	TI TI VEC ITT ITT	pnp,ge pnp,ge npn,PL,si -	25 25 25 28 28	.33 .33 .142 -	100 100 200 95 95	60 60 140 25 40	3.5 3.5 - 3 3	*30-75 *30-75 - 30 30	1 1 .750 1	6 6 - 15 15		KSC KSC
P 38	2N1757 2N1758 2N1759 2N1760 2N1761	1TT 1TT 1TT 1TT 1TT		28 28 28 28 28 28	1 1 1 1 1	95 95 95 95 95	55 65 25 40 55	3 3 3 3 3	30 30 60 60 60	1 1 1 1 1	15 15 15 15 15		KSC KSC KSC KSC KSC
	2N1762 KM7000 KM7001 KM7002 40250	ITT KSC KSC KSC RCA	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge npn, si	28 28 28 28 28 29	- - - - 0.194	95 100 100 100 200	65 *60 *100 80 40	3 3.0 3.0 3.0 4	60 - 150 - *25-100	1 - - - 1	15 10 9 -	- + + 66	KSC † MS-7 † MS-7 † MS-7
P 39	40310 40312 40316 40324 2N 1978	RCA RCA RCA RCA FA	npn, si npn, si npn, si npn, si npn, DP, si	29 29 29 29 29 30	0.16 0.16 0.16 0.16 0.172	200 200 200 200 200 200	35 - 40 35 *60	4 4 4 4	*20 - 120 *20 - 120 *20 - 120 *20 - 120 *30	0.01 0.01 0.01 0.01 .01	*750 *750 *750 *750 *50000	66 66 66 -	Vcer = 60
D.40	2N2150 2N2151 2N2869 2N2870 2N2877	TI TI RCA RCA SOL	npn, TD, si npn, TD, si pnp, AJ, ge pnp, A, ge npn, si	30 30 30 30 30	0.4 0.4 - - 0.3	175 175 100 100 200	80 80 *60 50 *80	2 2 10 10 5	*20-60 *40-120 *90 *90 *20-60	0. 01 0. 01 0.5 0.5 .0001	*20 *20 - 450 30000	21 †† 3 3	††MT 21 LAN LAN TI, SSP
P 40	2N2878 2N2879 2N2880 2N2892 2N2893	SOL SOL FA FA	npn,si npn,si npn,si npn,PE,si npn,PE,si	30 30 30 30 30	0.3 0.3 0.3 -	200 200 200 200 200 200	*80 *100 *100 80 80	5. 5 - -	*40-120 *20-60 *40-120 *55 *80	.0001 .0001 .0001 .0002 0.0002	50000 30000 50000 *50000 *50000	11111	TI, SSP TI, SSP TI, SSP AMP AMP
D.41	2N3220 2N3221 2N3222 2N3744 2N3745	GE GE GE SOL SOL	npn,si npn,si npn,si npn,si npn,si	30 30 30 30 30 30	0.4 0.4 0.4 .3 .3	175 175 175 200 200	80 80 60 *60 *80	2 2 2 5 5	80 160 8`` *20-60 *20-60	0.1 0.1 0.1 .0001	- - *30,000 *30,000	11111	TI TI TI hex isolated col. hex isolated col.
P 41	2N3746 2N3747 2N3748 2N3749 2N3750	SOL SOL SOL SOL	npn,si npn,si npn,si npn,si npn,si	30 30 30 30 30 30	.3 .3 .3 .3 .3	200 200 200 200 200 200	*100 *60 *80 *100 *60	5 5 5 5 5	*20-60 *40-120 *40-120 *40-120 *100-300	.0001 .0001 .0001 .0001	*30,000 *40,000 *40,000 *40,000 *50,000	11011	hex isolated col. hex isolated col. hex isolated col. hex isolated col. hex isolated col.
D 40	2N3751 2N3752 2N3850 2N3851 2N3852	SOL SOL SSP SSP SSP SSP	npn,si npn,si npn,TDP npn,TDP npn,TDP	30 30 30 30 30 30	.3 0.4 0.4 0.4	200 200 200 200 200 200	*80 *100 *100 *60 *60	5 5 5 5 5	*100-300 *100-300 *150 *90 *150	.0001 .0001 .0001 .0001	*50,000 *50,000 *40 *30 *40	- 59 59 59	hex isolated col. hex isolated col.
P 42	2N3853 2N3996 2N3997 2N3998 2N3999	SSP TI TI TI TI	npn,TDP npn,EP,si npn,EP,si npn,EP,si npn,EP,si	30 30 30 30 30 30	0.4 0.3 0.3 0.3 0.3	200 200 200 200 200 200	*60 80 80 80 80	5 5 5 5 5	*90 40-120 80-240 40-120 80-240	.0001 0.005 0.005 0.005 0.005 0.005	*30 40,000 40,000 40,000 40,000	59 - - - -	7/16 stud-isol 7/16 stud-isol 7/16 stud 7/16 stud

	2 7 52			Valey P	MA	. RATIN	GS	. 200	CHA	RACTERI	STICS		
Cross Index Key	Type No.	Mfr.	Туре	P _c (W)	w/°c	T _j (°C)	VCEO *VCBO (V)	l _c (A)	hfe *hFE	ICO *ICEO †ICEX (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
2.42	2N4075 2N4076 FT207A FT207B KM7011	FA FA FA KSC	npn,DPE,si npn,DPE,si npn,DPE,si npn,DPE,si pnp,AJ,ge	30 30 30 30 30	.171 .171 2.7 2.7	200 200 200 200 200 100	80 80 80 80 80	3 3 50 50 50 5.0	30-90 50-150 20 20	.0001 .0001 .0050 .0050	*30,000 *30,000 *3.5 *3500 8	59 59 59 - †	† MS-7
P 43	KM7012 KM7013 KM7014 KM7015 KM7016	KSC KSC KSC KSC KSC	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	30 30 30 30 30		100 100 100 100 100	60 80 100 60 80	5.0 5.0 5.0 5.0 5.0	-		8 8 8 10 10	† † † †	† MS-7 † MS-7 † MS-7 † MS-7 † MS-7 † MS-7
	KM7017 0C26 2N538 2N538A 2N539	KSC AMP SOL SOL SOL	pnp,AJ,ge pnp,A,ge pnp,ge pnp,ge pnp,ge	30 30 34 34 34	- .9 0.46 0.46 0.46	100 90 100 100 100	100 32 *80 *80 *80	5.0 3.5 3.5 3.5 3.5 3.5	- *60 *20-50 *20-50 *30-75	- .20 2. 2	10 150 200 200 200	† 3 - -	† MS-7 KSC KSC KSC
P 44	2N539A 2N540 2N540A 2N1202 2N1203	SOL SOL SOL SOL	pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge	34 34 34 34 34	0.46 .46 0.46 0.46 0.46	100 100 100 100 100	*80 *80 *80 *80 *120	3.5 3.5 3.5 3.5 3.5 3.5	*30/75 *45-113 *45-113 *200 *25-75	2 2 2 2 2	200 200 200 200 200 200	11111	KSC KSC KSC
	2N1261 2N1262 2N1263 2N1501 2N1502	SOL SOL SOL SOL	pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge	34 34 34 34 34	0.46 0.46 0.46 0.46 0.46	100 100 100 100 100	*80 *80 *80 *60 *40	3.5 3.5 3.5 3.5 3.5	*20-50 *30-75 *45-113 *25-100 *25-100	2 2 2. 2 2	200 200 200 200 200 200	1 - 1 - 1 -	KSC KSC KSC KSC
P 45	2N400 2N1011 2N2836 2N3583 2N3584	BE BE AMP RCA RCA	pnp;ge pnp,AJ,ge npn, si npn, si	35 35 35 35 35 35	- 0.5 .66 0.2 0.2	95 90 200 200	- *80 55 175 250	3 5 3.5 *5 *5	*30-40 *30-75 *30 40 *25-100	- 15 .1 *10 *5	11111	3 3 66 66	KSC DE, KSC, MO, ITT KSC
	2N3585 2N3878 40313 40318 40322	RCA RCA RCA RCA RCA	npn, si npn, si npn, si npn, si npn, si	35 35 35 35 35 35	0.2 0.2 0.2 0.2 0.2 0.2	200 200 200 200 200 200	300 50 - -	5 10 (pea 2 2 2	*25-100 *50-200 *40-250 *40(min.) *40(min.)	*5 *5 *5 *5	*10.000 *60,000 - -	66 66 66 66	Vcer=300 Vcer=300 Vcer=300
P 46	40328 40364 2N663 2N665 2N3154	RCA RCA DE DE ITT	npn,si npn,si pnp,AJ,ge pnp,AJ,ge	35 35 37.5 37.5 37.5	0.2 0.2 2 2	200 200 100 100 100	- 25 40 25	2 7 4 5 3	*20(min.) *35 - 175 *25 - 75 *40-80 60	*5 - 4 10 1	- *15 15 20 15	66 66 3	CER = 300
	2N3155 2N3156 2N3157 2N3158 2N4241	ITT ITT ITT ITT AMP	- - - - pnp, ge	37.5 37.5 37.5 37.5 37.5	- - - - 0.5	100 100 100 100 100	40 55 65 25 *32	3 3 3 5.0	60 60 60 30 *50	1 1 1 1 45	15 15 15 10 5	- - - - 3	KSC KSC KSC KSC
P 47	2N1047 2N1047A 2N1047B 2N1047C 2N1048	TI TI TI	npn,si pnp,si npn,si npn,si npn,si	40 40 40 40 40	0.228 0.228 0.228 0.228 0.228	200 200 200 200 200 200	*80 80 80 80 *120	0.500 0.500 0.750 1 0.500	*12 *12 *12 *12 *12	0.015 0.350 0.050 0.010 0.015			STC, TR STC, TR TJ STC, TR
	2N1048A 2N1048B 2N1048C 2N1049 2N1049A	TI TI TI	npn,si pnp,si npn,si pnp,si npn,si	40 40 40 40 40	0.228 0.228 0.228 0.228 0.228	200 200 200 200 200 200	120 120 120 *80 80	0.500 0.750 1 0.500 0.500	*12 *12 *12 *30 *30	0.350 0.100 0.010 0.015 0.350	1111	1,111	STC, TR TI STC, TR STC, TR
P 48	2N1049B 2N1049C 2N1050 2N1050A 2N1050B	TI TI TI	npn,si npn,si npn,si npn,si npn,si	40 40 40 40 40	0,228 0.228 0.228 0.228 0.228	200 - 200 - 200 - 200 - 200 -	80 80 *120 120 120	0.750 1 0.500 0.500 0.750	*30 *30 *30 *30 *30	0.050 0.010 0.015 0.350 0.100			TI STC, TR STC, TR STC, TI
	2N1050C 2N1647 2N1648 2N1649 2N1650	TI TR TR TR TR	npn,si npn,PL,si npn,PL,si npn,PL,si npn,PL,si	40 40 40 40 40	0.228 .267 .267 .267 .267	200 175 175 175 175	120 *80 120 *80 120	1 3 3. 3.	*30 *15-45 *15-45 *30-90 *20	0.010 .1 .1 .1	3,000 2,000 3,000 2,000		STC STC STC STC
P 49	2N 1690 2N 1691 2N 2018 2N 2019 2N 2020	TI TI TR TR TR	npn,si npn,si npn,PL,si npn npn,PL,si	40 40 40 40 40	0.228 0.228 .267 .267 .267	200 200 175 175 175	80 120 *150 *200 *150	500 500 2 2 2	*20 *20 *15 *15 *25	0.015 0.015 .1 .1	- 2,000 2,000 3,000		STC STC

(see pages 4-9 for explanation of company abbreviations.)

May 17, 1966

					MAX	(. RATIN	IGS		СН	ARACTERI	STICS		
Cross Index Key	Type No.	Mfr.	Туре	P _c (W)	w/°c	T _j	V CEO *V CBO (V)	l _c (A)	h _{fe} *h	ICO *ICEO †ICEX (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
D. 50	2N2021 2N2632 2N2633 2N2634 2N2828	TR SOL SOL SOL STC	npn,PL,si npn, si npn, si npn, si npn, si	40 40 40 40 40	.267 . 4 . 4 . 4 . 229	175 200 200 200 200 200	*200 *90 *120 *150 60	2 5. 0 5. 0 5. 0 3	*25 *40-120 *40-120 *40-120 *20-60	.1 0.0001 0.0001 0.0001	3000 20000 20000 20000 -	*1111	*7⁄a" Hex, TI
P 50	2N2829 2N2902 2N3551 2N4004 2N4005	STC TI TI TI TI	npn npn, TD, si npn, TD, si npn,EP,si npn,EP,si	40 40 40 40 40	.229 0.228 0.53 0.4 0.4	200 200 175 200 200	60 120 60 80 100	3 2 12 20 20	*20-60 *30-90 *20-90 *30-150 *30-150	- 0. 25 10 1	*2 *40 30,000 30,000	* 57 - - -	*7g" Hex , TI Thin-Pac Thin-Pac
	2N3552 2N3851 PT5692 2N2266 2N2267	TI TI TRWS SOL SOL	npn, EP, si npn, EP, si - pnp, ge pnp, ge	40 40 40 43 43	0.53 0.53 .229 0.5 0.5	175 175 200 125 125	80 60 40 *100 *120	12 12 4.0 5	*20-90 *20-90 10-80 *25-75 *25-75	10 10 4.0 2 2	40,000 40,000 2.5 200 200	1111	Isol Thin-Pac Isol Thin-Pac MT59 package
P 51	2N2268 2N2269 2N1120 2N456A 2N457A	SOL SOL BE TI TI	pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge	43 43 45 50 50	0.5 0.5 0.667 0.667 0.667	125 125 95 100 100	*100 *120 *80 *40 *60	5 5 15 7 7	*25-75 *25-75 30-120 *40 *40	2 2 15 0.5 0.5	200 200 - - -	- 41 3 3	MO, ITT DE, BE, MO, ITT DE, KSC, BE, MO, ITT
P 52	2N458A 2N463 2N678 2N678A 2N678B	TI † KSC BE BE BE	pnp,ge pnp,AJ,ge pnp,ge pnp,ge pnp,ge	50 50 50 50 50	0.667 .67 0.66 0.66 0.66	100 100 100 100 100	*80 *60 *15 *25 *60	7 5 15 15 15	*40 *20-100 *50-100 *50-100	0.5 0.3 2 2 5	4 5 - -	3 32 3 3 3	DE, BE, MO, ITT †WE Orig Reg KSC, TI, ITT TI, ITT TI, ITT
1 32	2N678C 2N1014 2N1021 2N1022 2N1069	BE TI TI	pnp,ge pnp,ge pnp,ge pnp,ge npn,ge	50 50 50 50 50	0.66 100 0.714 0.714	100 - 75 95 175	*60 *100 *100 *120 45	15 - 5 5 4	*50-100 *20 *60 *60 *10-50	5 - 0.10 0.13	- - - 10	3 - 3 3 3	TI, ITT KSC DE, KSC, BE, MO, ITT DE, KSC, BE, MO, ITT STC, BE
2.50	2N1070 2N1430 2N1722 2N1722A 2N1723	BE TI TI TI	npn,ge - npn,si npn,si npn,si	50 50 50 50 50	.33 - 0.667 0.67 0.67	175 - 175 175 175	45 40 80 120 80	4 10 5 5	*10-50 *30-100 *20 *30 *50	1 - 0.5 0.1 0.1	10 - - - -	3 41 53 53 53	STC, BE STC, TR, BE BE BE
P 53	2N1724 2N1724A 2N1725 2N1905 2N1906	TI TI TI RCA RCA	npn,si npn,si npn,si pnp, AJ, ge pnp, AJ, ge	50 50 50 50 50	0.667 0.67 0.67 —	175 175 175 100 100	80 120 80 *60 *100	5 5 3 3	*20 *30 *50 *90 *125	0.5 0.1 0.1 0.15 0.15	- - - *7500 *7500	- - 3 3	STC, TR, BE, MO BE BE, MO, TR LAN LAN
	2N2811 2N2812 2N2813 2N2814 2N236A	SOL SOL SOL BE	npn, si npn, si npn, si npn, si npn, si pnp, ge	50 50 50 50 60	0. 5 0. 5 0. 5 0. 5 0. 83	200 200 200 200 200 100	*80 *80 *120 *120	10 10 10 10 3	*20-60 *40-120 *20-60 *40-120	. 0001 . 0001 . 0001 . 0001	20000 30000 20000 30000	- - 61 3	TI TI TI TI KSC
P 54	2N236B 2N1073 2N1073A 2N1073B 2N1079	BE BE BE TR	pnp, ge pnp, ge pnp, ge pnp, ge npn,PL,si	60 60 60 60	0.83 0.833 0.833 0.833 .34	100 *110 *110 +110 +110	- *-25 *-60 *-100 *60	3 -10 -10 -10 3	*20-60 *20-60 *20-60 *20-80	15 20 20 10	- - - - 10,000	3 41 41 41 53	DE, MO DE, MO DE, MO
0.55	2N 1080 2N 1210 2N 1211 2N 1616 2N 1618	TR TR TR TR TR	npn,PL,si npn,PL,si npn,PL,si npn,PL,si npn,PL,si	60 60 60 60 60	.34 .40 .40 .40 .40	175 175 175 175 175 175	*60 60 *80 60 *100	3 5 5 5 5	*20-80 *15-75 *15-75 *15-75 *15-75	10 10 10 10 10	10,000 3,000 3,000 3,000 3,000	53 - 53 - -	BE BE, TI STC, BE, TI STC, BE, TI
P 55	2N1620 2N1907 2N1908 2N2288 2N2289	TR TI TI BE BE	npn,PL,si pnp,ge pnp,ge - -	60 60 60 60 60	.40 2 2 2 -	175 100 100 -	*100 *100 *130 -	5 20 20 10 10	*15-75 *20 *20 *20-60 *20-60	10 0.5 0.5 - -	3,000 - - - -	53 3 3 3 3	STC, BE, TI
D.C.	2N2290 2N2291 2N2292 2N2293 2N2294	BE BE BE BE BE	1111	60 60 60 60			11111	10 10 10 10 10	*20-60 *50-120 *50-120 *50-120 *50-120		3	3 3 3 3 41	ETC ETC ETC
P 56	2N2295 2N2296 2N2137 2N2137A 2N2138	BE BE MO MO	- pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	60 60 62.5 62.5 62.5	- 0.83 0.83 0.83	- 100 100 100	- 20 20 30	10 10 3 3 3	*50-120 50-120 *30-60 *30-60 *30-60	- 2 2 2	- 20 20 20 20	41 41 3 3 3	

- VIII.					MAX	RATIN	GS		СНА	RACTERI	STICS		
Cross Index Key	Type No.	Mfr.	Туре	P _c (W)	w/°c	T _j (°C)	V CEO *V CBO (V)	l _c (A)	h _{fe} *h	I _{C0} *I _{CE0} †I _{CEX} (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
P 57	2N2138A 2N2139 2N2139A 2N2140 2N2140A	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	62.5 62.5 62.5 62.5 62.5	0.83 0.83 0.83 0.83 0.83	100 100 100 100 100	30 45 45 60 60	3 3 3 3 3	*30-60 *30-60 *30-60 *30-60 *30-60	2 2 2 2 2 2	20 20 20 20 20 20	3 3 3 3 3 3	
F 37	2N2141 2N2141A 2N2142 2N2142 2N2142A 2N2143	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	62.5 62.5 62.5 62.5 62.5	0.83 0.83 0.83 0.83 0.83	100 100 100 100 100	65 65 20 20 30	3 3 3 3	*30-60 *30-60 *50-100 *50-100	2 2 2 2 2 2	20 20 20 20 20 20	3 3 3 3	
D.F0	2N2143A 2N2144 2N2144A 2N2145 2N2145A	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	62.5 62.5 62.5 62.5 62.5	0.83 0.83 0.83 0.83 0.83	100 100 100 100 100	30 45 45 60 60	3 3 3 3	*50-100 *50-100 *50-100 *50-100 *50-100	2 2 2 2 2 2	20 20 20 20 20 20	3 3 3 3 3	ETC ETC ETC ETC
P 58	2N2146 2N2146A 2N554 2N555 2N4070	MO MO MO MO SOL	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge npn,si	62.5 62.5 65 65	0.83 0.83 0.72 0.72 .66	100 100 90 90 200	65 65 *15 *30 *120	3 3 3 10	*50-100 *50-100 55 55 *40-120	2 2 10 20 .0001	20 20 6 6 *20,000	3 3 3 3 3	ETC ETC ITT DE, KSC, ITT
2.50	2N4071 2N1430 2N3223 2N1487 2N1488	SOL BE GE RCA RCA	npn,si pnp,ge npn,si npn,si npn,si	65 70 70 75 75	.66 0.833 0.4 .429 .429	200 110 175 200 200	*200 100 60 40 55	10 10 2 6 6	*40-120 *30-90 160 *15-45 *15-45	.0001 - 0.1 .025 .025	*20,000 - - 30 30	3 41 - 3 3	TI STC, BE, TI STC, BE, TI
P 59	2N1489 2N1490 2N1511 2N1512 2N1513	RCA RCA RCA RCA RCA	npn,si npn,si npn,si npn,si npn,si	75 75 75 75 75	.429 .429 .429 .429 .429	200 200 200 200 200 200	40 55 40 55 40	6 6 6 6	*25-75 *25-75 *15-45 *15-45 *25-75	.025 .025 .025 .025 .025	30 30 30 30 30 30	3 3 36 36 36	STC, BE, TI STC, BE, TI STC STC STC
P 60	2N1514 2N1703 2N2912 40369 3N45	RCA RCA MO RCA SOL	npn,si npn,si pnp,EP,ge npn,si pnp,ge	75 75 75 75 75 75	.429 200 1 0.429	200 .429 110 200 100	55 40 6 55 *60	6 5 25 3 12	*25-75 *15-60 *75 *25 - 75 *30-120	.025 .2 0.2 0.01 3	30 25 - 600	36 36 8 3 15	STC STC 75w@ 35°C
F 00	3N46 3N47 3N48 DTG600 DTG601	SOL SOL DE DE	pnp,ge pnp,ge pnp,ge pnp,PADT,ge pnp,PADT,ge	75 75 75 75 75	1 1 1 1.0 1.0	100 100 100 110 110	*80 *40 *60 *90 90	12 12 12 25 25	*20-80 *30-120 *20-80 115 115	3 3 - -	300 500 300 —	15 15 15 3 3	
P 61	DTG602 2N3264 2N3266 2N389 2N424	DE RCA RCA TI TI	pnp,PADT,ge npn, si npn, si npn,si npn,si npn,si	75 † 84 84 85 85	1.0 0.66 0.66 0.485 0.485	110 200 200 200 200 200	100 90 90 - -	25 25 25 1.5 0.75	115 *20-80 *20-80 12 12	- 10 10 - -	11111	3 - 63 53 53	†Tc = 75C, TI TI TR, STC , BE TR, STC , BE
1 01	2N1210 2N1235 2N1260 2N2383 2N2384	TI TI TI STC STC	npn, TD, si npn,si npn,si npn npn	85 85 85 85 85	0. 425 0.485 0.485 .5	200 200 200 200 200 200	60 *100 *120 60 60	2 2 2 3 3	*15 *12 *12 *20-60 *20-60	0. 25 10 10 - -	*2 - - - -	53 53 53 - *	STC * ¹¹ / _% " Hex
D 62	2N2526 2N2527 2N2528 2N2832 2N2833	MO MO MO MO	pnp,AD,ge pnp,AD,ge pnp,AD,ge pnp,EP,ge pnp,EP,ge	85 85 85 85 85	1 1 1 1	110 110 110 110 110	80 120 160 50 75	10 10 10 20 20	*20-50 *20-50 *20-50 *25-100 *25-100	3 3 3 .3 .3	12 12 12 50 50	3 3 3 3	
P 62	2N2834 2N2908 2N3577 2N3611 2N3612	MO STC TI MO MO	pnp,EP,ge npn npn, TD, si pnp,AJ,ge pnp,AJ,ge	85 85 85 85 85	1 .45 0.565 1	110 200 175 110 110	100 *80 80 25 35	20 5 2 7 7	*25-100 *12-60 *12-60 *35-70 *35-70	.3 - 0.1 0.04 0.04	50 - *10 - -	3 53 53 3,41 3,41	2
D.Co.	2N3613 2N3614 2N3615 2N3616 2N3617	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	85 85 85 85 85	1 1 1 1	110 110 110 110 110	25 35 50 60 50	7 7 7 7 7	*60-120 *60-120 *30-60 *30-60 *45-90	0.04 0.04 0.06 0.06 0.06	-	3,41 3,41 3,41 3,41 3,41	
P 63	2N3618 MP2060 MP2061 MP2062 MP2063	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	85 85 85 85 85	1 1 1 1	110 110 110 110 110	60 25 35 50 60	7 7 7 7 7	*45-90 *30-200 *30-200 *30-200 *30-200	0.06 0.06 0.06 0.06 0.06		3,41 3 3 3 3	

FOUR SPECIALISTS

(and what they can do for you)

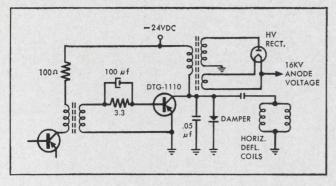
Control of the second of the s

These four high power Nu-Base germanium transistors were created to relieve some special problems where reliable peak power handling is a requirement. Each is in a class by itself with special benefits for ignition, TV horizontal sweep circuits and high power audio output (tentative specifications are provided).

These are rugged, durable transistors with built-in protection against secondary breakdown (thanks to Delco's Hydrokinetic Alloy process). Extreme parameter stability is a result of our Surface Passivation and Ambient Control (SPAC).

THE DTG-1110

This is a 200-volt 15-amp transistor with high power dissipation characteristics, low thermal resistance and a rugged performance record.



TV horizontal deflection incorporating the DTG-1110.

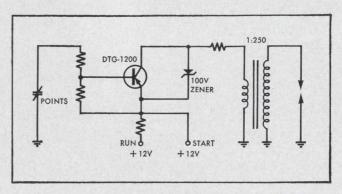
The drive requirements for your circuits are substantially reduced because of the high saturated current gain of this special application transistor.

THE DTG-1010

A 325-volt 15-amp transistor, this device's higher voltage offers many advantages. It's ideal for switching high inductive loads as found in many CRT deflection circuits.

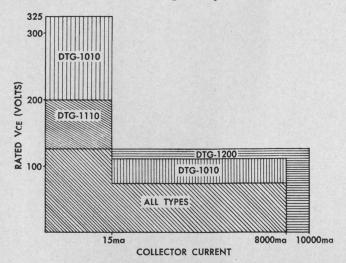
THE DTG-1200

With a (VCE Sus) rating of -120 volts, it offers excellent gain, high speed and high sustaining voltage characteristics.



Automobile ignition circuit with the DTG-1200.

It's the ideal transistor for an ignition circuit. Also can be used in fluorescent light power inverter circuits. Mobile or portable operation is possible and fluorescent tube efficiency is improved due to higher oscillation frequency.



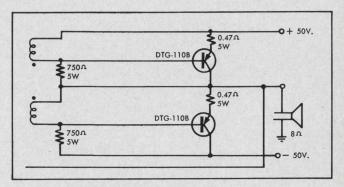
Tested sustaining voltage areas of the DTG-1110, DTG-1010 and DTG-1200.

THE DTG-110B

The DTG-110B is a high power transistor which will substantially reduce component costs and improve the reliability of quality home entertainment audio output circuits. It's designed especially for use in high fidelity amplifiers.

The linear gain and the specific gain band-width product of the DTG-110B offer low distortion and improved amplifier gainphase characteristics.

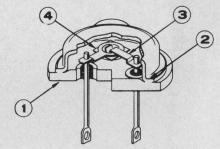
Exceptional efficiency in the driver stages is possible because of the DTG-110B's superb transconductance properties.



This two-stage output circuit produces well in excess of 50 watts RMS audio power with a simple drive requirement.

THE TO-3 PACKAGE

Delco Radio's TO-3 package wraps up this group of transistors.



With its solid copper base (1), maximum thermal resistance is just 0.8° per watt, and freedom from conventional weld contamination is assured with Delco cold weld construction (2). The TO-3 heavy-duty connectors (3) offer high current ruggedness, and the large germanium wafer (4) delivers high continuous and peak power handling ability.

Totally, four Nu-Base specialists in Delco TO-3 packages. For data, prices and delivery, call one of our sales offices or your Delco Radio Semiconductor Distributor.

	DTG-1110	DTG-1010	DTG-1200	DTG-110B
Collector Emitter Voltage (VCE SUS)			-120V	-40V
Collector to Emitter Voltage (VCEX)	-200V	325V		-90V
Collector Emitter Voltage (VCEO)		ENTRADA Y		-40V
*Emitter Diode Voltage (VEBO)	-1.0V	-1.0V	-1.0V	-2V
Collector Current (IC)	—15A	—15A	—15A	-25A
Base Current (IB)	—3A	—3A	—3A	—5A
Maximum Junction Temperature	110°C	110°C	110°C	110°C
Minimum Junction Temperature	−65°C	−65°C	-65°C	-65°C
Lead Temperature $\frac{1}{16}'' \pm \frac{1}{32}''$ from case for 2 seconds	245°C	245°C	245°C	245°C

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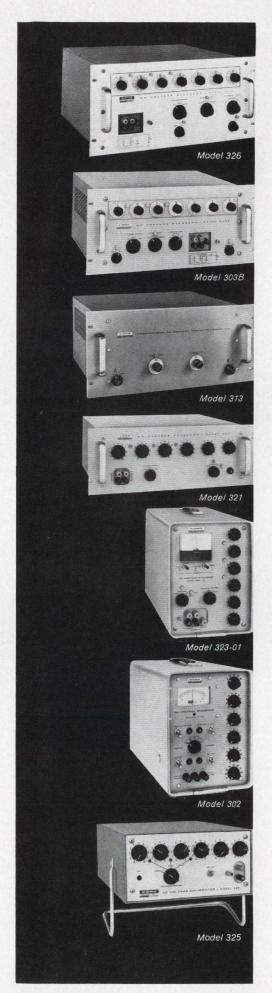
*Office includes field lab and resident engineer for application assistance.

Division of General Motors, Kokomo, Indiana

					MAX	. RATIN	IGS		CHA	RACTERIS	TICS		
Cross Index Key	Type No.	Mfr.	Туре	P _c (₩)	w/°c	T _j (°C)	V CEO *V CBO (V)	I _c (A)	h _{fe} *h	ICO *ICEO †ICEX (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
	2N176 2N178 2N250A 2N251A 2N257	MO MO TI TI CL	pnp,AJ,ge pnp,ge pnp,ge pnp,ge	90 90 90 90 90	1.2 1.43 0.42 1.2	100 90 100 100 100	*40 30 *40 *60 35	3 3 7 7 5	*25-90 *15-45 *35 *35	- 3 1 2 2	7 5 - - 5	3 3 3 3 3	DE, KSC, ITT KSC KSC, BE, ITT KSC, BE, ITT KSC, BE
P 64	2N268 2N268A 2N297A 2N350A 2N351A	ITT ITT ITT MO MO	- - pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	- - 1.2 1.2	100 100 100 100 100	60 60 60 *50 *50	5 5 5 3 4	20 20 20 20-60 *25-90	2 2 2 3 3	6 - - 5 5	3 3 3 3 3	KSC, BE KSC, BE MO, KSC, BE, DE KSC, BE KSC, ITT
P 65	2N375 2N376A 2N627 2N628 2N629	MO MO MO MO MO	pnp, AJ, ge pnp, AJ, ge pnp, AJ, ge pnp, ge pnp, AJ, ge	90 90 90 90 90	1. 2 1.2 1.2 1.2 1.2	100 100 100 100 100	*80 *50 *40 *60 *80	3 5 10 10 10	*35-90 *35-120 *10-30 *10-30 *10-30	20 3 20 20 20	7 5 8 8 8	3 3 3 3	KSC, ITT KSC KSC KSC
P 03	2N637 2N637A 2N637B 2N638 2N638A	BE BE BE BE BE	-	90 90 90 90 90	- - - -		30 55 65 30 65	5 5 5 5 5	30-60 *30-60 *30-60 *20-40 *30-60		- - - - -	3 3 3 3 3	KSC KSC KSC KSC KSC
	2N638B 2N669 2N677 2N677A 2N677B	BE MO BE BE BE	pnp,AJ,ge pnp,ge pnp,ge pnp,ge pnp,ge	90 90 90 90 90	- 1.6 0.66 0.66 0.66	100 100 100 100 100	65 *40 20 30 60	5 3 15 15 15	*20-40 90 *20-60 *20-60 *20-60	- 3 - -	- 5 - - -	3 3 3 3	KSC DE, KSC KSC, TI, ITT KSC, TI, ITT KSC, TI, ITT
P 66	2N677C 2N1031 2N1031A 2N1031B 2N1031C	BE BE BE BE BE	pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge	90 90 90 90 90	0.66 1.25 1.25 1.25 1.25	100 100 100 100 100	70 *50 *60 *90 *100	15 15 15 15 15	*20-60 *20-60 *20-60 *20-60 *20-60	15 15 15 15 15	- - - -	3 41 41 41 41	KSC, TI, ITT TI, ITT TI, ITT TI, ITT TI, ITT
200	2N1032 2N1032A 2N1032B 2N1032C 2N1136	BE BE BE BE BE	pnp,ge pnp,ge pnp,ge pnp,ge	90 90 90 90 90	1.25 1.25 1.25 1.25 1.25	100 100 100 100	*50 *60 *90 *100 30	15 15 15 15 5	*50-100 *50-100 50-100 *50-100 *50-100	15 15 15 15 15	-	41 41 41 41 3	ITT ITT ITT ITT KSC, ITT
P 67	2N1136A 2N1136B 2N1137 2N1137B 2N1138	BE BE BE BE BE	=	90 90 90 90 90			55 65 30 65 30	5 5 5 5 5	*50-100 *50-100 75-150 *75-150 100-200	- - - -	- - - -	3 3 3 3	KSC, ITT KSC, ITT KSC, ITT KSC, ITT KSC, ITT
D.Co	2N1138A 2N1138B 2N1146 2N1146A 2N1146B	BE BE ITT ITT ITT	-	90 90 90 90 90	-	- 100 100 100	55 65 20 30 60	5 5 15 15 15	100-200 100-200 60 - 60	- 4 4 4	- 4 4 4	3 3 3 3 3	KSC, ITT KSC, ITT BE KSC, BE KSC, BE
P 68	2N1146C 2N1147 2N1147A 2N1147B 2N1147C	ITT ITT ITT ITT		90 90 90 90 90	- - -	100 100 100 100 100	7.5 20 30 60 75	15 15 15 15 15	60 60 - 60 60	4 4 4 4 4	4 4 4 4 4	3 3 3 3 3	KSC, BE BE, TI KSC, BE, TI KSC, BE, TI KSC, BE, TI
D 00	2N1162 2N1162A 2N1163 2N1163A 2N1164	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	*50 *50 *50 *50 *80	25 25 25 25 25 25	*65 *65 *65 *65 *65	3	4 4 4 4	3 3 3 3	BE, (TT BE BE, ITT BE BE, ITT
P 69	2N1164A 2N1165 2N1165A 2N1166 2N1166A	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	*80 *80 *80 *100 *100	25 25 25 25 25 25	65 *65 *65 *65 *65	- - - -	4 4 4 4 4	3 3 3 3	BE BE, ITT BE BE, ITT BE
D 70	2N1167 2N1167A 2N1359 2N1360 2N1362	MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	*100 *100 *50 *50 *100	25 25 3 3	*65 *65 *35-90 *60-140 *35-90	- 3 3 3	4 4 10 8.5 10	3 3 3 3	BE, ITT BE KSC, BE KSC, BE KSC, BE
P 70	2N1363 2N1364 2N1365 2N1529 2N1529A	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	*100 *120 *120 *120 *40 *40	3 3 5 5	*60-140 *35-90 *60-140 *20 *20	3 3 3 2 2	8.5 10 8.5 10 10	3 3 3 3	KSC, BE KSC, BE KSC, BE KSC, BE KSC, BE

					MA	K. RATIN	GS		CI	HARACTER	STICS		
Cross Index Key	Type No.	Mfr.	Туре	P _c (₩)	w/°c	T _j (°C)	V CEO *V CBO (Y)	l _c (A)	h _{fe} *h	ICO *ICEO †ICEX (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
P 71	2N1530 2N1530A 2N1531 2N1531A 2N1532	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	*60 *60 *80 *80 *100	5 5 5 5 5	*20 *20 *20 *20 *20 *20	2 2 2 2 2 2	10 10 10 10 10	33333	KSC, BE KSC, BE KSC, BE KSC, BE KSC, BE
F/1	2N1532A 2N1533 2N1534 2N1534A 2N1535	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	*100 *120 *40 *60 *60	5 5 5 5 5	*20 *20 *35 *35 *35	2 2 2 2 2 2	10 10 8.5 8.5 8.5	3 3 3 3 3 3	KSC, BE KSC, BE DE, KSC, BE, ITT KSC, BE DE, KSC, BE, ITT
D 70	2N1536 2N1536A 2N1537 2N1537A 2N1538	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	*80 *80 *100 *100 *120	5 5 5 5 5	*35 *35 *35 *35 *35 *35	2 2 2 2 2	8.5 8.5 8.5 8.5 8.5	3 3 3 3	DE, KSC, BE, ITT KSC, BE KSC, BE, ITT KSC, BE KSC, BE, ITT
P 72	2N1539 2N1539A 2N1540 2N1540A 2N1541	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	*40 *40 *60 *60 *80	5 5 5 5	*50 *50 *50 *50 *50	2 2 2 2 2 2	4 4 4 4	3 3 3 3	DE, KSC, BE, TI, ITT KSC, BE DE, KSC, BE, TI, ITT KSC, BE DE, KSC, BE, TI, ITT
P 73	2N1541A 2N1542 2N1542A 2N1543 2N1544	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge prip,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	*80 *100 *100 *120 *40	5 5 5 5 5	*50 *50 *50 *50 *75	2 2 2 2 2	4 4 4 4	3 3 3 3 3	KSC, BE DE, KSC, BE, TI, ITT KSC, BE DE, KSC, BE, TI, ITT DE, KSC, BE, IT, ITT
F /3	2N1544A 2N1545 2N1545A 2N1546 2N1546A	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	*40 *60 *60 *80 *80	5 5 5 5 5	*75 *75 *75 *75 *75	2 2 2 2 2 2	4 4 4 4	3 3 3 3	KSC, BE DE, KSC, BE, ITT KSC, BE DE, KSC, BE, ITT KSC, BE
P 74	2N1547 2N1547A 2N1548 2N1549 2N1549A	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	*100 *100 *120 20 20	5 5 5 15 15	*75 *75 *75 *10 *10	2 2 2 3 3	4 4 4 10 10	3 3 3 3 3	DE, KSC, BE, ITT KSC, BE KSC, BE, ITT KSC, BE, ITT KSC, BE
Г/4	2N1550 2N1551 2N1551A 2N1552 2N1552A	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	30 40 40 50 50	15 15 15 15 15	*10 *10 *10 *10 *10	3 3 3 3	10 10 10 10 10	3 3 3 3	KSC, BE, ITT KSC, BE, ITT KSC, BE KSC, BE, ITT KSC, BE
P 75	2N1553 2N1553A 2N1554 2N1554A 2N1555	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	20 20 30 30 40	15 15 15 15 15	*30 *30 *30 *30 *30	3 3 3 3 3	6 6 6	3 3 3 3 3	KSC, BE, TI, ITT, DE KSC, BE KSC, BE, TI, ITT, DE KSC, BE KSC, BE, TI, ITT, DE
F /3	2N1555A 2N1556 2N1556A 2N1557 2N1557A	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	40 50 50 20 20	15 15 15 15 15	*30 *30 *30 *50 *50	3 3 3 3	6 6 5 5	3 3 3 3	KSC, BE KSC, BE, TI, ITT, DE KSC, BE KSC, BE, ITT, DE KSC, BE
P 76	2N1558 2N1558A 2N1559 2N1559A 2N1560	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	90 90 90 90 90	1.2 1.2 1.2 1.2 1.2	100 100 100 100 100	30 30 40 40 50	15 15 15 15 15	*50 *50 *50 *50 *50	3 3 3 3	5 5 5 5 5	3 3 3 3 3	KSC, BE, 1TT, DE KSC, BE KSC, BE, ITT, DE KSC, BE KSC, BE, ITT, DE
1 70	2N1560A 2N2061A 2N2062A 2N2063A 2N2064A	MO ITT ITT ITT ITT	pnp,AJ,ge - - - -	90 90 90 90 90	1.2 - - - - -	100 100 100 100 100	50 15 15 20 20	15 5 5 5 5	*50 20 50 20 50	3 2 2 2 2	5 5 1 5	3 3 3 3	KSC, BE
P 77	2N2065A 2N2066A 2N2423 DTG411 3N49	ITT ITT ITT DE SOL	- - npn,TDP,si pnp,ge	90 90 90 90 90	- - 0.8 1,25	100 100 100 150 100	40 40 75 300 *60	5 5 1.0 15	20 50 20 *90 *30-120	5 5 5 1 3	5 1 3 - 600	3 3 3 -	KSC
	3N50 3N51 3N52 2N2285 2N2286	SOL SOL SOL BE BE	pnp,ge pnp,ge pnp,ge - -	94 94 94 100 100	1.25 1.25 1.25 - -	100 100 100 -	*80 *40 *60 30 60	15 15 15 25 25	*20-80 *30-120 *20-80 *20 *20	3 3.0 3.0 -	300 500 300 -	- - 3 3	

					MAX	. RATIN	IGS		CHA	RACTERIS	TICS		(1)
Cross Index Key	Type No.	Mfr.	Туре	P _c (W)	w/°c	T _j (°C)	YCEO *VCBO (Y)	I _c (A)	h _{fe}	ICO *ICEO †ICEX (mA)	fae *f _T (kHz)	Package Outline (TO-)	Remarks
	2N2287 2N3597 2N3598 2N3599 2N4002	BE SOL SOL TI	- npn,si npn,si npn,si npn,EP,si	100 100 100 100 100	- 1 1 1 1	200 200 200 200 200	80 *60 *80 *100 80	25 20 20 20 20 30	*20 *40-120 *40-120 *40-120 20-80	0.0001 0.0001 0.0001 1	30000 30000 30000 30,000	3 * * 63	*7/" hex, TI *7/" hex, TI *7/" hex, TI
P 78	2N 4003 151-04 151-05 151-06 151-07	TI WH WH WH	npn,EP,si npn,AJ,si 'npn,AJ,si npn,AJ,si npn,AJ,si	100 100 100 100 100	1 1.4 1.4 1.4 1.4	200 150 150 150 150 150	100 *80 *100 *120 *140	30 6.0 6.0 6.0 6.0	*20-80 *11 *11 *11 *11	1 10 10 10 10	*30,000 25 25 25 25 25	63 † † † † †	† MT-1 † MT-1 † MT-1 † MT-1
D 70	151-08 151-09 151-10 151-12 151-14	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	100 100 100 100 100	1.4 1.4 1.4 1.4 1.4	150 150 150 150 150 150	*160 *180 *200 *145 *165	6.0 6.0 6.0 6.0 6.0	*11 *11 *11 *11 *11	10 10 10 10 10	25 25 25 25 25 25	++	† MT-1 † MT-1 † MT-1
P 79	151-16 151-18 151-20 152-04 152-05	WH WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	100 100 100 100 100	1.4 1.4 1.4 1.4 1.4	150 150 150 150 150 150	*185 *205 *225 *80 *100	6.0 6.0 6.0 6.0 6.0	*11 *11 *11 *18 *18	10 10 10 10 10	25 25 25 25 25 25	- - + +	† MT-1 † MT-1
P.OC	152-06 152-07 152-08 152-09 152-10	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	100 100 100 100 100	1.4 1.4 1.4 1.4 1.4	150 150 150 150 150 150	*120 *140 *160 *180 *200	6.0 6.0 6.0 6.0 6.0	*18 *18 *18 *18 *18	10 10 10 10 10	25 25 25 25 25 25	† † † †	† MT-1 † MT-1 † MT-1 † MT-1 † MT-1
P 80	152-12 152-14 152-16 152-18 152-20	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	100 100 100 100 100	1.4 1.4 1.4 1.4	150 150 150 150 150	*145 *165 *185 *205 *225	6.0 6.0 6.0 6.0 6.0	*18 *18 *18 *18 *18	10 10 10 10 10	25 25 25 25 25 25	11111	
	40355 DTS -423 40363 2N3442 2N3445	RCA DE RCA RCA MO	npn, si npn, si npn, si npn, si npn, AE, si	100 100 115 117 117	1000 1.33 0.657 0.668 0.66	175 150 200 200 200 200	6.6 400 70 140 80	*150 3.5 15 10 7.5	50 30-90 *20-70 *20-70 *20-60	- - - 5 0.1	.005(max 6000 *700 -	2.8 3 3 3 3	Icer=0.5 mA
P 81	2N3446 2N3447 2N3448 2N3487 2N3488	MO MO MO MO MO	npn,AE,si npn,AE,si npn,AE,si npn,AE,si npn,AE,si	117 117 117 117 117	0.66 0.66 0.66 0.66 0.66	200 200 200 200 200 200	60 80 60 60 80	7.5 7.5 7.5 7.5 7.5 7.5	*20-60 *40-120 *40-120 *20-60 *20-60	0.1 0.1 0.1 0.025 0.025		3 3 61 61	
	2N3489 2N3490 2N3491 2N3492 40251	MO MO MO MO RCA	npn,AE,si npn,AE,si npn,AE,si npn,AE,si npn,AE,si npn, si	117 117 117 117 117	0.66 0.66 0.66 0.66 0.668	200 200 200 200 200 200	100 60 80 100 40	7.5 7.5 7.5 7.5 7.5	*15-45 *40-120 *40-120 *30-90 *15-60	0.025 0.025 0.025 0.025 5	Ī	61 61 61 61 3	
P 82	40325 156-04 156-06 156-08 156-10	RCA WH WH WH WH	npn,si npn,DJ,si npn,DJ,si npn,DJ,si npn,DJ,si	117 120 120 120 120	0.668 0.68 0.68 0.68 0.68	200 200 200 200 200 200	35 40 60 80 100	15 8 8 8 8	*12-60 *15 *15 *15 *15 *15	5 20 20 20 20 20	- 60 60 60 60	3	
D.CC	2N1899 2N1900 2N1901 2N1902 2N1903	TRWS TRWS TRWS TRWS TRWS	npn,PL,si npn,PL,si npn,PL,si npn,PL,si npn,PL,si	125 125 125 125 125 125	1.0 1.0 1.0 1.0	150 150 150 150 150	*140 *140 *140 *140 *140	10 10 10 10 10	5.0 *>8 5 5 *>8	10 10 10 10 10	2500 5000 2000 5000 5000	LILLI	
P 83	2N1904 2N3076 2N3263 2N3265 DTS430	TRWS TRWS RCA RCA DE	npn,PL,si npn,PL,si npn, si npn, si npn, TDP,si	125 125 † 125 † 125 † 125 125	1 1.0 1 1 0.7	150 150 200 200 150	*140 *140 60 60 400	10 10 25 25 25 2.5	5 5 *25-75 *25-75 *45	10 25 4 4	2000 2000 - - *4000	- - 63 3	†Tc = 75C, TI †Tc = 75C, TI
	DTS431 2N2733 2N2734 2N2735 2N2736	DE SOL SOL SOL	npn, TDP, si pnp, ge pnp, ge pnp, ge pnp, ge	125 141 141 141 141	0.7 1.67 1.67 1.67 1.67	150 110 110 110 110	400 *80 *60 *40 *80	2.5 65 65 65 65	*35 *30-120 *30-120 *30-120 *30-120	5.0 5.0 5.0 5.0	*4000 350 350 350 350 350	3	
P 84	2N2737 2N2738 2N173 2N174 2N174A	SOL SOL DE DE DE	pnp,ge pnp,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	141 141 150 150 150	1.67 1.67 .5 .5	110 110 100 100 100	*60 *40 45 55 40	65 65 15 15 15	*30-120 *30-120 *37-70 *25-50 *40-80	5.0 5.0 4 4 8	350 350 10 10	- 36 36 36 36	MO, RCA MO, RCA MO



precision dc voltage standards now available with accuracies to 0.003% stability to 15 ppm from Cohu Electronics

- COHU'S NEW MODEL 326 DC VOLTAGE STANDARD: an exceptionally accurate and stable source with a wide range of voltages at extremely low output impedance. Output voltages from 0 to ± 1222.2221 volts in 3 decade ranges, with steps as small as 1 μ V, and an accuracy of 0.003% of setting; stability within 15 ppm for 7 days, 25 ppm for 6 months; output current to 50 mA; output impedance less than (0.00025 \pm 0.00005E_{out}) ohms at DC; noise and hum less than 20 μ V rms. \$2490.00.
- MODEL 303B DC VOLTAGE STANDARD: highly accurate, direct setting, stable output over a wide range of voltages. Specifications: output voltage accuracy to within 0.01% of setting; output voltage from 0 to ± 1111.1110 volts in 3 decade ranges, steps as small as 1 μ V; output current to 25 mA; stability within 25 ppm for 7 days, 50 ppm for 6 months; noise and hum less than 40 μ V rms. \$2000.00.
- MODEL 313 PROGRAMABLE DC VOLTAGE STANDARD: from 0 to \pm 1111.1110 volts in any desired sequence. The instrument automatically responds to any program applied in the form of parallel entry, 1-2-4-4 BCD signals; output voltage accuracy is within 0.01%; stability is within 25 ppm for 8 hours and 50 ppm for 30 days; noise and hum is less than 40 μ V rms; output current up to 25 mA; maximum settling time of output approx. 1 second. \$3995.00.
- MODEL 321/323 DC VOLTAGE STANDARDS: accurate, stable voltages, to 25 mA current in rackmount or cabinet configurations. Voltage range 0 to ± 1111.110 volts with steps as small as 10 μ V; output voltage accuracy within 0.01% of dial settings; stability is within 25 ppm for 8 hours and 50 ppm for 30 days; output noise and hum less than 40 μ V rms; Model 321 (rackmount) or 323 (cabinet) versions available with or without nullmeter. \$1600.00 to \$1900.00.
- MODEL 302 DC VOLTAGE STANDARD AND NULL VOLTMETER: range 1.000 to 502.110V; short term stability, ± 25 ppm $\pm 25 \mu$ V; output current to 20 mA; accuracy within 0.01% of setting $\pm 200 \mu$ V. \$1495.00.
- MODEL 325 DC VOLTAGE CALIBRATOR: a stable dc voltage source with an accuracy within 0.02%. Output voltage is from 0 to ± 1111.110 V in steps as small as 10 μ V; output current to 25 mA; lightweight; portable. \$995.00.

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					MAX	. RATI	IGS		СНА	ARACTERIS	TICS		
Cross Index Key	Type No.	Mfr.	Туре	P _c (W)	w/°c	T _j (°C)	V CEO *V CBO (V)	I _c (A)	h _{fe}	ICO *ICEO †ICEX (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
	2N277 2N278 2N441 2N442 2N443	DE DE DE DE DE	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	150 150 150 150 150	.5 .5 .5 .5	100 100 100 100 100	25 30 25 30 45	15 15 15 15 15	*35-70 *35-70 *20-40 *20-40 *20-40	8 4 8 4 4	10 10 10 10 10	36 36 36 36 36 36	MO, RCA MO, RCA MO, RCA MO, RCA MO, RCA
P 85	2N511 2N511A 2N511B 2N512 2N512A	TI TI TI TI	pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge	150 150 150 150 150	2 2 2 2 2 2	100 100 100 100 100	*40 *60 *80 *40 *60	25 25 25 25 25 25	*20 *20 *20 *20 *20 *20	0.5 0.5 0.5 0.5 0.5	-	-	
D 06	2N512B 2N513 2N513A 2N513B 2N514	TI TI TI TI	pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge	150 150 150 150 150	2 2 2 2 2 2.14	100 100 100 100 95	*80 *40 *60 *80 40	25 25 25 25 25 25	*20 *20 *20 *20 *20 *40	0.5 0.5 0.5 0.5 0.2	 	-	
P 86	2N514A 2N514B 2N1015C 2N1099 2N1100	TI TI WH DE DE	pnp,ge pnp,ge npn, AJ, si pnp,AJ,ge pnp,AJ,ge	150 150 150 150 150	2.14 2.14 1.43 .5	95 95 150 100 100	50 60 150 55 65	25 25 7.5 15	*40 *40 *10 *35 70 *25-50	0.2 0.2 10 4	25 10 10	- - 36 36	STC MO, RCA MO, RCA
P 87	2N1358 2N1412 2N1412USN 2N1936 2N1937	DE DE DE TI TI	pnp, AJ, ge pnp, AJ, ge pnp, AJ, ge npn, si npn, si	150 150 150 150 150	0.5 0.5 .5 2	100 100 100 175 175	-80 100 60 60 80	-15 15 15 20 20	*40-80 *25-50 *25-50 *12 *12	-4 4 4 - -	100 10 10 - -	36 36 36 -	RCA RCA MO
P 87	2N2015 2N2016 2N2226 2N2227 2N2228	RCA RCA WH WH	npn,si npn,si npn,AJ,si npn,AJ,si npn,AJ,si	150 150 150 150 150	.855 .855 2 2 2	200 200 150 150 150	50 65 50 100 150	10 10 10 10 10	*15-50 *15-50 *100 *100 *100	.05 .05 10 10	25 25 10 10 10	36 36 † † †	STC STC +MT 1 +MT 1 +MT 1
D 00	2N2229 2N2230 2N2231 2N2232 2N2233	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	150 150 150 150 150	2 2.0 2.0 2.0 2.0 2.0	150 150 150 150 150	200 50 100 150 200	10 10 10 10 10	*100 *400 *400 *400 *400	10 10 10 10 10	10 7 7 7 7	† † † †	† MT 1 † MT 1 † MT 1 † MT 1 † MT 1
P 88	2N2338 2N3429 2N3430 2N3431 2N3432	RCA WH WH WH WH	npn, si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	150 150 150 150 150	0.855 1.33 1.33 1.33 1.33	200 175 175 175 175 175	40 *50 *100 *150 *200	7.5 7.5 7.3 7.5 7.5	*15-60 *10 *10 *10 *10 *10	0. 2 10 10 10 10	20 30 30 30 30 30	36 - - - -	
D 00	2N3433 2N3434 2N3470 2N3471 2N3472	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	150 150 150 150 150	1.33 1.33 2 2 2 2	175 175 150 150 150	*250 *30 *50 *100 *150	7.5 7.5 10 10	*10 *10 *100 *100 *100	10 1 0 10 10 10	30 30 10 10	-	
P 89	2N3473 2N3474 2N3475 2N3476 2N3477	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	150 150 150 150 150	2 2 2 2 2 2	150 150 150 150 150	*200 *50 *100 *150 *200	10 10 10 10 10	*100 *400 *400 *400 *400	10 10 10 10 10	10 10 10 10 10	-	
D 00	2N3713 2N3714 2N3715 2N3716 2N3771	MO MO MO MO RCA	npn,si npn,si npn,si npn,si npn,si	150 150 150 150 150	.857 .857 .857 .857 0.855	200 200 200 200 200 200	60 80 60 80 40	10 10 10 10 30	*25-90 *25-90 *50-150 *50-150 *15-60	†1 †1 †1 †1 †1 2	*4000 *4000 *4000 *4000 *700	3 3 3 3	
P 90	2N3772 2N3773 2N3789 2N3790 2N3791	RCA RCA MO MO MO	npn, si npn, si pnp, si pnp, si pnp, si pnp, si	150 150 150 150 150	0.855 .855 .857 .857 .857	200 200 200 200 200 200	60 140 60 80 60	30 30 10 10	*15-60 *15-60 *25-90 *25-90 *50-150	5 2 †1 †1 †1	*700 *500 *4000 *4000 *4000	3 3 3 3 3	
	2N3792 2N3846 2N3847 2N3848 2N3849	MO TI TI TI TI	pnp,si npn,TDM,si npn,TDM,si npn,TDM,si npn,TDM,si	150 150 150 150 150	.85/ ? 2 2 2	200 175 175 175 175 175	80 200 300 200 300	10 20 20 20 20 20	*50-150 *15-60 *15-60 *15-60 *15-60	†1 2 2 2 2	*4000 10,000 10,000 10,000 10,000	3 · 63 63 63 63	
P 91	TI3027 TI3028 TI3029 TI3030 TI3031	TI TI TI TI	pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge	150 150 150 150 150	2 2 2 2 2 2	100 100 100 100 100	*45 *60 *80 *100 *120	7 7 7 7 7	*40 *40 *40 *40 *40	1 1 1 1 1	- - - -	3 3 3 3 3	

10		6			MA	X. RATIN	IGS		СН	ARACTERI	STICS		
Cross Index Key	Type No.	Mfr.	Туре	P _c (W)	w/°c	т _ј (°С)	V CEO *V CBO (V)	I _с (А)	h _{fe} *h	ICO *ICEO †ICEX (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
P 92	2N3146 2N3147 2N2075 2N2075A 2N2076	TI TI MO MO MO	pnp,ge pnp,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	150 150 170 170 170	2 2 2 2 2 2	100 100 110 110 110	*150 180 65 65 55	15 15 15 15 15	*30-90 30-90 *25-100 *25-100 *25-100	10 10 4 4 4	- - 5 5 5	3 3 36 36 36	DE DE
F 92	2N2076A 2N2077 2N2077A 2N2078 2N2078A	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	170 170 170 170 170	2 2 2 2 2 2	110 110 110 110 110 110	55 45 45 25 25	15 15 15 15 15	*25-100 *25-100 *25-100 *25-100 *25-100	4 4 4 4 4	5 5 5 5	36 36 36 36 36	DE DE
P 93	2N2079 2N2079A 2N2080 2N2080A 2N2081	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	170 170 170 170 170	2 2 2 2 2 2	110 110 110 110 110	65 65 55 55 45	15 15 15 15 15	*40-160 *40-160 *40-160 *40-160 *40-160	4 4 4 4 4	5 5 5 5 5	36 36 36 36 36	DE DE
F 93	2N2081A 2N2082 2N2082A 2N2152 2N2152A	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	170 170 170 170 170	2 2 2 2 2 2	110 110 110 110 110	45 25 25 30 30	15 15 15 30 30	*40-160 *40-160 *40-160 *50-100	4 4 4 4 4	5 5 5 2.7 2.7	36 36 36 36 36	DE
P 94	2N2153 2N2153A 2N2154 2N2154 2N2156	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp, AJ,ge pnp,AJ,ge	170 170 170 170 170	2 2 2 2 2 2	110 110 110 110 110	45 45 60 60 30	30 30 30 30 30 30	*50-100 *50-100 *50-100 *50-100 *80-160	4 4 4 4 4	2.7 2.7 2.7 2.7 2.7 2.7	36 36 36 36 36	
P 94	2N2156A 2N2157 2N2157A 2N2157A 2N2158 2N2158A	MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	170 170 170 170 170	2 2 2 2 2	110 110 110 110 110	30 45 45 60 60	30 30 30 30 30	*80-160 *80-160 *80-160 *80-160 *80-160	4 4 4 4 4	2.7 2.7 2.7 2.7 2.7 2.7	36 36 36 36 36	
P 95	2N2357 2N2358 2N2359 2N2728 2N2730	BE BE BE MO SOL	- - pnp,AJ,ge pnp, ge	170 170 170 170 170 170	- - 2 2.0	- - 110 110	30 60 80 5 *80	50 50 50 50 65	*15 *15 *50 *40-130 *30-120	- - - 5. 0	- - - 4.5 350	41 41 41 36 36	
F 35	2N2731 2N2732 2N3311 2N3312 2N3313	SOL SOL MO MO MO	pnp,ge pnp,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	170 170 170 170 170	2 2 2 2 2	110 110 110 110 110	*60 *40 20 30 40	65 65 5 5	*30-120 *30-120 60-120 60-120 60-120	5 5 0.3 0.3 0.3	350 350 1.0 1.0	36 36 36 36 36	
D OS	2N3314 2N3315 2N3316 2N4048 2N4049	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge* pnp,ge pnp,ge	170 170 170 170 170 170	2 2 2 2 2	110 110 110 110 110	20 30 40 30 45	5 5 60 60	100-200 100-200 100-200 *60-120 *60-120	0.3 0.3 0.3 4 4	1.0 1.0 1.0 2 2	36 36 36 36 36	
P 96	2N4050 2N4051 2N4052 2N4053 MP500	MO MO MO MO MO	pnp,ge pnp,ge pnp,ge pnp,ge pnp,AJ,ge	170 170 170 170 170	2 2 2 2 2 2	110 110 110 110 110	60 30 45 60 30	60 60 60 60	*60-120 *80-180 *80-180 *80-180 *30-60	4 4 4 4	2 2 2 2 2 3.6	36 36 36 36 36	
P 97	MP500A MP501 MP501A MP502 MP502A	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	170 170 170 170 170	2 2 2 2 2	110 110 110 110 110	30 45 45 60 60	60 60 60 60	*30-60 *30-60 *30-60 *30-60	4 4 4 4 3	3.6 3.6 3.6 3.6 3.6	36 36 36 36 36	
F 3/	MP504 MP504A MP505 MP505A MP506	MO MO MO MO MO	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	170 170 170 170 170	2 2 2 2 2 2	110 110 110 110 110	30 30 45 45 45	60 60 60 60	*50-100 *50-100 *50-100 *50-100 *50-100	4 4 4 4	3.6 3.6 3.6 3.6 3.6	36 36 36 36 36	
D 00	MP506A 2N2580 2N2581 2N2582 2N2583	MO DE DE DE DE	pnp,AJ,ge pnp,DD,si npn,DD,si npn,DD,si npn,DD,si	170 178 178 178 178	2 .7 .7 .7	110 150 150 150 150	45 400 400 500 500	60 10 *@10A *@5A 10	*50-100 10-40 *10 *10-40 10	4 - -	3.6 50 50 50 50	36 36 36 36 36	
P 98	2N574 2N574A 2N575 2N575A 2N1157	SOL SOL SOL SOL	pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge	187 187 187 187 187	2.5 2.5 2.5 2.5 2.5	100 100 100 100 100	*60 *80 *60 *80 *60	10 10 25 25 40	*9-22 *9-22 *19-42 *19-42 *38-84	7 20. 7 20. 7	100 100 150 150 200	1 1 1 1 1	

					MAX	. RATIN	GS		CHA	RACTERIST	rics		
Cross Index Key	Type No.	Mfr.	Туре	P _c (W)	w/°c	T _j (°C)	V CEO *V CBO (V)	l _c (A)	h _{fe} *h	ICO *ICEO †ICEX (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
	2N1157A 2N2739 2N2740 2N2741 2N2742	SOL WH WH WH	pnp,ge npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	187 200 200 200 200 200	2.5 2 2 2 2	100 175 175 175 175 175	*80 50 100 150 200	40 20 20 20 20 20	*38-84 *10 *10 *10 *10	20. 15 15 15 15	200 14 14 14 14	- † + -	† MT 1 † MT 1
P 99	2N2745 2N2746 2N2747 2N2748 2N2751	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	200 200 200 200 200 200	2 2 2 2 2 2	175 175 175 175 175 175	50 100 150 200 50	20 20 20 20 20 20	*10 *10 *10 *10 *10	15 15 15 15 15	14.5 14.5 14.5 14.5 16	† † † †	† MT 1 † MT 1 † MT 1 † MT 1 † MT 1
D.100	2N2752 2N2753 2N2754 2N2757 2N2758	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	200 200 200 200 200 200	2 2 2 2 2 2	175 175 175 175 175 175	100 150 200 50 100	20 20 20 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	16 16 16 14 14	† † † †	†MT 1 †MT 1 †MT 1 †MT 33 †MT 33
P 100	2N2759 2N2760 2N2761 2N2763 2N2764	WH WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	200 200 200 200 200 200	2 2 2 2 2 2	175 175 175 175 175 175	150 200 250 50 100	30 30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	14 14 14 14.5 14.5	† † † †	† MT 33 † MT 33 † MT 33 † MT 33 † MT 33
9 1/s	2N2765 2N2766 2N2769 2N2770 2N2771	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	200 200 200 200 200 200	2 2 2 1 2	175 175 175 175 175 175	150 200 50 100 150	30 30 30 30 30 30	*10 *10 *10 10 *10	15 15 15 15 15	14.5 14.5 16 16 16	† † † †	† MT 33 † MT 33 † MT 33 † MT 33
P 101	2N2772 2N2815 2N2816 2N2817 2N2818	WH STC STC STC STC	npn,AJ,si npn npn npn npn	200 200 200 200 200 200	2 1 1 1 1	175 200 1.0 200 200	200 80 100 150 200	30 20 20 20 20 20	*10 *10-50 *10-50 *20-60 *10-50	15 - - - -	16 - - - -	† * * *	† MT 33 *7/" Hex, TI * 7/6" Hex, TI *7/6" Hex, TI *7/6" Hex, TI
5.100	2N2819 2N2820 2N2821 2N2822 2N2823	STC STC STC STC STC	npn npn npn npn npn	200 200 200 200 200 200	1 1 1 1 1	200 200 200 200 200 200	80 100 150 200 80	25 25 25 25 25 30	*10-50 *10-50 *10-50 *10-50 *10-40	-		* * * * *	*7 ₈ " Hex, TI *7 ₈ " Hex, TI *7 ₆ " Hex, TI *7 ₈ " Hex, TI *7 ₈ " Hex, TI
P 102	2N2824 2N2825 153-04 153-06 153-08	STC STC WH WH	npn npn npn, AJ, si npn, AJ, si npn, AJ, si	200 200 200 200 200 200	1 1 1.33 1.33 1.33	200 200 175 175 175	100 150 65 85 105	30 30 7.5 7.5 7.5	*10-40 *10-40 *15 *15 *15	- 10 10 10	- 33 33 33 33	* *	*7/ ₈ " Hex, TI *7/ ₈ " Hex, TI
	153-10 153-12 153-14 153-16 153-18	WH WH WH WH	npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si	200 200 200 200 200 200	1.33 1.33 1.33 1.33 1.33	175 175 175 175 175 175	125 145 165 185 205	7.5 7.5 7.5 7.5 7.5 7.5	*15 *15 *15 *15 *15	10 10 10 10 10	33 33 33 33 33		
P 103	153-20 154-04 154-06 154-08 154-10	WH WH WH WH	npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si	200 200 200 200 200 200	1.33 1.33 1.33 1.33 1.33	175 175 175 175 175	225 *65 85 105 125	7.5 7.5 7.5 7.5 7.5 7.5	*15 *25 *25 *25 *25	10 10 10 10 10	33 33 33 33 33		
	154-12 154-14 154-16 154-18 154-20	WH WH WH WH	npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si	200 200 200 200 200 200	1.33 1.33 1.33 1.33 1.33	175 175 175 175 175	145 165 185 205 225	7.5 7.5 7.5 7.5 7.5 7.5	*25 *25 *25 *25 *25 *25	10 10 10 10 10	33 33 33 33 33		
P 104	163-06 163-08 163-10 163-12 163-14	WH WH WH WH	pnp, AJ, si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	200 200 200 200 200 200	2.0 2 2 2 2 2	175 175 175 175 175 175	75 95 115 135 155	20 20 20 20 20 20	*15 *15 *15 *15 *15	15 15 15 15 15	22 22 22 22 22 22	† † † †	† MT33 † MT 33 † MT 33 † MT 33 † MT 33
	163-18 163-20 164-04 164-06 164-08	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	200 200 200 200 200 200	2 2 2 2 2	175 175 175 175 175 175	175 215 55 75 95	20 20 20 20 20 20	*15 *15 *25 *25 *25	15 15 15 15 15	22 22 22 22 22 22	† † † †	† MT 33 † MT 33 † MT 33 † MT 33 † MT 33
P 105	164-10 164-12 164-14 164-16 164-18	WH WH WH WH WH	npn,AJ,si npn, AJ,si npn, AJ,si npn, AJ,si npn, AJ,si	200 200 200 200 200 200	2 2.0 2.0 2.0 2.0 2.0	175 175 175 175 175 175	115 135 155 175 195	20 20 20 20 20 20	*25 *25 *25 *25 *25	15 15 15 15 15	22 22 22 22 22 22	† † † †	† MT 33 † MT 33 † MT 33 † MT 33 † MT 33

INSPIRATIONAL THOUGHTS FOR THE TECHNICALLY INCLINED

ITTSY BITS

Why the baby talk? We're bubbling with happiness over our latest baby. It's the fifth generation of a native-born family, and although the smallest, it is undoubtedly the best today by virtue of its breeding. This latest offspring is the new Size 11 Shaft Encoder we have named ADAC. Now ADAC, like its ancestors, is characterized by engraved drums which are interconnected by high-speed, antibacklash, continuous gearing and by special brushes which interrogate and read out the drum position on the run or at rest.



At this point we can almost hear you say, "So what's new about that?" It's an all-around better baby! First of all, the ADAC is a high-speed device designed to run at 200 rpm input shaft speed. It can be interrogated on a bit-by-bit basis in 1 millisecond while on the run. Even more important, it packs a lot of bits into a tiny)ackage - for example, in a can only 1 062" in diameter and 2.355" long, you can buy a count of 16.384 bits (214). We have also included all the advantages of V scan (U scan optional) for unambiguous binary outputs and

have incorporated all necessary diode logic as well.

ADAC units are available as binary encoders covering the range of 28 through 214. We also have BCD encoders in decimal counts to 99999 and angular counts to 359.9°. A 21° gray code device is also available.

To give you a better idea of the new encoder's breeding, we think these statistics will prove helpful.

TYPE SIZE 11 UNITS

CHARACTERISTIC	BINARY	BCD
Voltage/Current	28vdc/20ma	28vdc/20ma
Interrogation	Pulsed or continuous	Serial
Readout	On run an	d static
Output	Parallel	Parallel digit, serial between digits
Time Sharing		are standard to permit e sharing
Counts per revolution	126 or 256	100
Starting Torque	0.20 in. oz.	0.20 in. oz.
Accuracy	± 1 bit for any g	iven input shaft angle
Life	5,000,000 revolu	itions at 300 rpm (min)



SUMMARY OF OTHER FEATURES

- Solid gold alloy drums and brushes In-line brush geometry
- Continuous precision gearing
- Flush conducting and nonconducting drum surface ■ Steel shafts and precision bearings
- Standard Size 11 mounting
- Isolation diodes for positive and negative logic included.

The proud parents are anxious to send you a brand new brochure celebrating the event, so let us know who you are and where we can find you.

INERTIA

Sometimes it takes a sharp push to get things going. We say we're working against inertia. At other times we pull and haul to get things "off the dime" overcoming a kind of viscous unwillingness. But inertia and viscosity can be real advantages instead of irritants. There are times, for example, when a tach generator (we make them, too) can be replaced by a viscous or inertial damped servo motor. There's been a lot written on the subject, and we're not going to discuss the obvious advantages of these devices except for the following summary and an invitation to write for more details.

TYPICAL DAMPED SERVOMOTOR CHARACTERISTICS

	PE-AISCORS	
SIZE	8	8
Part Number	CMO 0180 450	CMO 1302 450
Stall Torque	0.26 in. oz.	0.31
No-Load Speed	5190 rpm	6200
Rotor Moment of Inertia	0.69 gm cm ²	0.48
Theoretical Accel at Stall	28,600 rad/sec ²	48,500
Time Constant	0.0531 sec	0.0119
Fly Wheel Damping	_	196 dyne-cm-sec
Fly Wheel Inertia	_	4.6 gm cm ²
Weight	2.0 oz.	2.6

TYPE-INERTIAL													
	SIZE	11	15	18									
	Part Number	CRO 1300 660	T1310-41B	R1320-2B									
	Stall Torque	0.60	1.45	2.25									
	No-Load Speed	6000	4500	4500									
	Rotor Moment of Inertia	1.45	5.48	6.25									
	Theoretical Accel at Stall	30,700	18,700	26,000									
	Time Constant	0.022	0.0255	0.0185									
	Fly Wheel Damping	100	750	750									
	Fly Wheel Inertia	10	100	100									
	Weight	6.0	12.0	18									

KEARFOTT DIVISION



AEROSPACE GROUP Little Falls, New Jersey

					MAX	. RATIN	GS		С	HARACTERIS	TICS		
Cross Index Key	Type No.	Mfr.	Туре	P _c (₩)	w/°c	T _j (°C)	V CEO *V CBO (V)	I _c (A)	h _{fe} *h	ICO *ICEO †ICEX (mA)	fae *fT (kHz)	Package Outline (TO-)	Remarks
P 106	164-20 2N2902 2N1809 2N1810 2N1811	WH TI WH WH WH	npn, AJ, si npn, si npn, AJ, si npn, AJ, si npn, AJ, si	200 240 250 250 250	2.0 1.37 2.22 2.22 2.22	175 200 175 175 175	215 120 50 100 150	20 0.5 30 30 30	*25 30 *10 *10 *10	15 0.005 15 15 15	22 - 14 14 14	† † †	† MT 33 † MT 14 † MT 14 † MT 14
P 106	2N1812 2N1813 2N1814 2N1816 2N1817	WH WH WH WH	npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si	250 250 250 250 250	2.22 2.22 2.22 2.22 2.22 2.22	175 175 175 175 175	200 250 300 50 100	30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	14 14 14 14.5 14.5	† † † †	† MT 14 † MT 14 † MT 14 † MT 14 † MT 14
P 107	2N 18 18 2N 18 19 2N 18 23 2N 18 24 2N 18 25	WH WH WH WH	npn, AJ, si npn, AJ, si npn, AJ, si npn, AJsi npn, AJ, si	250 250 250 250 250 250	2.22 2.22 2.22 2.22 2.22 2.22	175 175 175 175 175	150 200 50 100 150	30 30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	14. 5 14. 5 16 16 16	† † † †	† MT 14 † MT 14 † MT 14 † MT 14 † MT 14
P 107	2N 1826 2N 1830 2N 1831 2N 1832 2N 1833	WH WH WH WH	npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si	250 250 250 250 250 250	2. 22 2. 22 2. 22 2. 22 2. 22 2. 22	175 175 175 175 175	200 50 100 150 200	30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	16 14 14 14 14	† † † †	† MT 14 † MT 14 † MT 14 † MT 14 † MT 14
D 100	2N2109 2N2110 2N2111 2N2111 2N2112 2N2113	WH WH WH WH WH	npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si	250 250 250 250 250 250	2. 22 2. 22 2. 22 2. 22 2. 22 2. 22	175 175 175 175 175 175	50 100 150 200 250	30 30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	14 14 14 14 14	† † † †	† MT 17 † MT 17 † MT 17 † MT 17 † MT 17 † MT 17
P 108	2N2114 2N2116 2N2117 2N2118 2N2119	WH WH WH WH WH	npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si	250 250 250 250 250 250	2.22 2.22 2.22 2.22 2.22 2.22	175 175 175 175 175	300 50 100 150 200	30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	14 14. 5 14. 5 14. 5 14. 5	† † † †	† MT 17 † MT 17 † MT 17 † MT 17 † MT 17
D 100	2N2123 2N2124 2N2125 2N2126 2N2130	WH WH WH WH	npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si	250 250 250 250 250 250	2. 22 2. 22 2. 22 2. 22 2. 22	175 175 175 175 175 175	50 100 100 150 50	30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	16 16 16 16 14	++++	† MT 17 † MT 17 † MT 17 † MT 17 † MT 17
P 109	2N2131 2N2132 2N2133 2N3149 2N3150	WH WH WH STC STC	npn,AJ,si npn,AJ,si npn,AJ,si npn npn	250 250 250 300 300	2.22 2.22 2.22 2 2	175 175 175 200 200	100 150 200 80 100	30 30 30 70 70	*10 *10 *10 *10 *10	15 15 15 - -	14 14 14 - -	† † * *	† MT 17 † MT 17 † MT 17 *1 ¹ / _M " Hex *1 ¹ / _M " Hex
	2N3151 DTG-1010 DTG1200 DTG-2000 DTG-2100	STC DE DE DE DE	pnp, ge pnp,ge pnp,ge pnp,ge	300 - - - -	2 0.8 1.25 1.25 1.25	200 110 110 110 110 110	150 *325 *120 60 *80	70 15 15 25 25	*10 *12 0.2 *25 *25	- - 10 10	250 250 250 250 250	* 3 33	*1 ¹ / ₁₆ Hex
P 110	DTG-2200 DTG-2300 DTG-2400 DTS-413 2N4079	DE DE DE DE AMP	pnp,ge pnp,ge pnp,ge npn,si 2N4077 & 2N	- - - 4078 combine	1.25 1.25 1.25 0.8 ed to form ma	110 110 110 110 150 tched comp	100 *120 *140 400 plementary	25 25 25 2.0 pajr	*25 *25 *25 20-80	10 10 10 -	250 250 250 5000	3 3 3 3	
P 111	2N4107 2N4136	AMP AMP	2N4105 & 2N 2N2430 & 2N										



This 5 MHz counter/timer from Monsanto is only $3\frac{1}{2}$ inches high, and weighs just 16 pounds. Yet it gives you a time base range from 1μ second to 100 seconds in decade steps, and resolution for frequency measurement of 0.01 Hz.

HOW COME? Integrated circuits. In 90% of the active circuits. That's how Monsanto builds big performance into a small package. Plus speed, accuracy, reliability, low power consumption, low heat generation and easy maintenance. Six of the 13 printed circuit boards are interchangeable.

HOW MUCH? Just \$1575. And that low selling price

goes with these "high-priced" specs:

• Measures average frequency: 0-5 MHz • Measures average periods: $0.2~\mu$ sec. to 1 sec. • Measures single periods: $1~\mu$ sec. to 10^6 sec. • Measures frequency ratios: 10^{-6} to 10^6 • Measures time intervals: $1~\mu$ secto 10^6 sec. • Counts: random or uniformly spaced signals. Want to know more? Just clip the coupon.



MONSANTO, ELECTRONICS DEPT. 800 NORTH LINDBERGH BLVD. • ST. LOUIS, MO
Details, please, on the Model 1010 5 MHz Counter/Timer Model 1000 20 MHz Counter/Timer
Name/Title
Firm
Address
City/State/Zip

Low-Level Switching

Generally types rated under one watt. In order of fae or fr.

						M	AX. RAT	INGS		(CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Туре	f _{αė} *f _T (MHz)	P _c (mW)	T _j (°c)	mW/°C	V CEO *V CBO (V)	C (mA)	h _{fe} *hFE	Ι _{C0} *Ι _{CE0} (μΑ)	Coe *Cob (pF)	V _{ce(sat)}	Package Outline (TO-)	Remarks
LL 1	2N327A 2N328A 2N328B 2N329	RA RA TI RA	pnp, si pnp, si pnp, PL, si pnp, si	0.05 0.05 0.05 0.05	380 380 500 340	160 160 200 160	2.9 2.9 2.9 2.5	40 35 35 35 30	50 50 50 50	*15 *30 *30 60	0.1 0.1 .001 0.1	*110 *110 110 *110	0.3 0.5 0.5 1.0	5 5 5	SSD, CT, STC, ETC, SPR SSD, CT, STC, ETC, TI, SPR SPR
	2N329A 2N329B	RA TI	pnp,si pnp,'PL,si	0.05	380 500	200	2.9	30	50	*60	.001	*110	0.6	5	SSD, CT, STC, ETC, SPR, TI
LL 2	2N1034 2N1035 2N1036 2N1037	RA RA RA RA	pnp,si pnp,si pnp,si pnp,si	0.05 0.05 0.05 0.05	250 250 250 250 250	160 160 160 160	1.85 1.85 1.85 1.85	40 35 30 35	50 50 50 50	15 30 60 25	1 1 1 1	*110 *110 *110 *110	0.5 0.4 0.3 0.5	5 5 5 5	KSC, CT, ETC, SPR KSC, CT, ETC, SPR KSC, CT, ETC, SPR KSC, CT, ETC, SPR KSC, CT, ETC, SPR
	2N1275 2N1640 2N1641 2N519 2N519A	RA CT CT GI GI	pnp,si pnp,SYM pnp,SYM pnp,AJ,ge pnp,AJ,ge	0.05 *0.4 *.8 1	250 250 250 100 150	160 160 160 85 100	1.85 1.9 1.9 1.67 2.0	80 20 10 *15 *20	50 50 50 -	*15 *6 *10 15	1 .01 .01 2 2	*110 *50 *50 *14 *14	0.3	5 5 5 5 5	CT, SPR TI TI, IND
	2N943 2N946 2N944 2N945 2N1091	SSD SSD SSD SSD RCA	AJ AJ AJ AJ npn,AJ,ge	1 1 1 1	250 250 250 250 250 120	175 175 175 175 175 85	1.67 1.67 1.67 1.67	18 80 18 50 *25	50 50 50 50 400	- - - *40	.002 .004 .003 .004 8	*14 *14 *14 *14 *25	.003 .005 .004 .005	18 18 18 18 5	CT, Chopper Pairs, SPR CT, Chopper Pairs, SPR CT, Chopper Pairs, SPR CT, Chopper Pairs, SPR GI
LL 3	2N1614 2N3342 2N3344 2N3345 2N3346	GE SSD SSD SSD SSD	pnp, AJ, ge pnp, AJ pnp, AJ pnp, AJ pnp, AJ	1 1 1 1 1	240 250 250 250 250 250	85 175 175 175 175 175	4 1.7 1.7 1.7 1.7	12 8 30 50 50	300 50 50 50 50	*32 *30 *25 *15 *25	25 0. 02 0. 002 0. 005 0. 005	*10 *12 *12 *12 *12	90 0. 1 0. 0012 0. 003 0. 0015	- 5 5 5 5	SPR SPR SPR SPR
	2N3842 2N3977 2N3978 2N3979 2N1642	SPR SPR SPR SPR CT	pnp,PE,si pnp,PE,si pnp,PE,si pnp,PE,si pnp,SYM	*1 1 1 1 *1,2	300 400 400 400 400 250	200 200 200 200 200 160	1.7 2.3 2.3 2.3 1.9	120 10 20 35 6	100 100 100 100 50	1 *40 *30 *20 15	.020 0.001 0.001 0.001 .1	*9 *14 *14 *14 *50	0.10 0.10 0.15	18 46 46 46 5	Chopper Chopper Chopper Chopper
LL 4	2N594 2N3841 2N356 2N356A 2N426	TI SPR GI GI TI	npn,AJ,ge pnp, PE,si npn,AJ,ge npn,AJ,ge pnp,AJ,ge	*1.5 *1.5 3 3	150 300 100 150 150	85 200 85 100 100	2.5 1.7 2.0 2.0 2.5	20 100 *20 *30 *30	300 100 - - 400	50 1.5 *20-50 *20-50 *30-60	5 .002 5 5 25	17 *9 *14 *14 *20	- .20 .20 .32	5 18 5 5 5	Chopper TI TI
	2N520 2N528A 2N585 2N595 2N1012	GI GI RCA TI GI	pnp,AJ,ge pnp,AJ,ge npn,AJ,ge npn,AJ,ge npn,AJ,ge	3 3 *3 *3	100 150 120 150 150	85 100 71 85 100	1.67 2.0 - 2.5 2.0	*15 *20 *25 15 *35	200 300	20 40 *20 75 *40	2 2 3 5 5	*14 *14 - 17 *20	- 0.1 - .20	5 5 9 5 5	TI GI
LL 5	2N1051 2N1694 2N2946 T-404 2N404	GE CT NUC	npn,DD,si npn,ge pnp,si pnp,ge pnp,AJ,ge	3 3 *3 3.5 4	500 75 400 120 150	150 85 200 80 85	4 - 2.3 -	40 20 *40 *25 24	100 25 100 100 100	30-100 *50 *30 - *24	.1 1.5 .0005 5	*7 6 *10 *20	3.0 · - 0.2 · 1	5 5 46 1 5	NA AMP, GI, TI, RCA, NUC
	2N404A 2N1605 2N1605A 2N1808 2N1169	RCA RCA RCA TI RCA	pnp,AJ pnp, AJ, ge pnp, AJ, ge npn,AJ,ge npn,AJ,ge	4 4 4 4 4.5	150 150 200 150 120	85 100 100 100 71	2.5	35 *25 *40 25 18	100 100 100 300	24 *40 *40 *125 *20	2 5 10 5 10	*20 *20 *20 *20	.1 0. 15 0. 15 .15	5 5 5 5 5	NUC TI
LL 6	2N1170 2N315 2N315A 2N315B 2N388	RCA GI GI GI TI	npn,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	4.5 5 5 5	120 100 150 150 150	71 85 100 100 100	- 2 2 2 2 2	20 *20 *25 *30 25	200 200 200 200 500	*20 *15-30 *20-50 *20-50 *60-180	8 2 2 2 10	19 *14 *14 *14 *20	- .15 .15 .15	5 5 5 5 5	AMP TI, IND TI, IND
	2N388A 2N427 2N596 2N858 2N1090	TI TI TI *SPR RCA	pnp,AJ,ge pnp,AJ,ge npn,AJ,ge pnp,SP,si npn,AJ,ge	5 5 *5 *5 5	150 150 150 150 150 120	100 100 85 140 85	2 2.5 2.5 1.3	40 *30 10 40 *25	500 400 300 50 400	*60-180 *40-80 100 33 *30	10 25 5 0.1 8	*20 *20 17 *5 *25	- .32 - 0.07	5 5 5 18 5	*PH orig Reg, CT GI
LL 7	2N2945 2N3677 2N357 2N357A 2N859	CT CT GI GI *SPR	pnp,si pnp,si npn,AJ,ge npn,AJ,ge pnp,SP,si	*5 5 6 6 *6	400 400 100 150 150	200 200 85 100 140	2.3	25 20 *20 *30 40	100 100 - - 50	*40 - *20-50 *25-75 65	.0002 .001 5 5 0.1	*10 6 *14 *14 *5	- .001 .20 .20 0.06	46 46 5 5 18	TI TI *PH orig Reg, CT

Low-Level (continued)

						М	AX. RAT	INGS		(CHARACT	ERISTICS			
Cross Index Key	Type No.	Mfr.	Туре	fαe *fT (MHz)	P c (mW)	T _j (°c)	mW/°C	VCEO *VCBO (V)	1 C (mA)	h _{fe} *h	l _{C0} *l _{CE0} (μA)	C _{oe} *C _{ob} (pF)	V _{ce(sat)}	Package Outline (TO-)	Remarks
	2N1319 2N2274 2N2275 2N2276 2N2277	RCA *SPR *SPR *SPR *SPR	pnp,AJ,ge pnp,SP,si pnp,SP,si pn p,SP,si pnp,SP,si	6 *6 *6 *6 *6	120 150 150 150 150 150	71 140 140 140 140	- 1.3 1.3 1.3 1.3	*20 25 25 *15 *15	400 50 50 50 50 50	*30 *15 *15 *15 *15	2.5 0.003 0.003 0.003 0.003	*20 *6.0 *6.0 *6.0 *6.0	0.2 - - - -	5 18 18 18 18	TI Chopper, *PH orig Reg, CT M. Pair 2N2274*PH orig Reg, CT Chopper, *PH Orig Reg, CT M. Pair 2N2276 *PH orig Reg, CT
LL 8	2N3840 3N123 UD-1001 UD-1002 UD-1003	SPR SPR SPR SPR SPR	pnp,PE,si pnp,PE,si npn,PE,si npn,PE,si pnp,PE,si	*6 6 6	400 100 200 200 200 200	200 200 200 200 200 200	2.3 0.58 1.1 1.1 1.1	50 *30 30 30 50	100 20 20 20 20 20	1.5	.0005 0.01 0.010 0.010 0.010	*9 *10 *8 *8 *8	11111	46 72 90 -	Chopper Dual Twin Dual Twin Dual, 8 lead flat pack Twin Dual, 8 lead flat pack
	UD-2000 2N3317 2N860 2N2185 2N2186	SPR SPR *SPR	pnp,PE,si pnp,SP,si pnp,SP,si pnp,SP,si pn p,SP,si	6 *6.4 *6.5 *6.5 *6.5	400 150 150 150 150	200 140 140 140 140	- 1.3 1.3 1.3 1.3	50 30 25 30 30	100 50 50 50 50	*50 -33 -	0.001 .001 0.1 0.001 0.001	*6 *9 *5 *6.0 *6.0	0.1 - 0.07 -	- 18 18 18 18	Twin Dual, 6 lead flat pack Chopper *PH orig Reg, CT Chopper; CT, SPR M. Pair 2N2185; *PH orig Reg, CT
LL 9	2N2187 2N1000 2N1119 2N861	GI *SPR *SPR	pnp,SP,si npn,AJ,ge pnp,SAT,si pnp,SR,si	*6.5 7 *7.2 *7.5	150 150 150 150 150	140 100 140 140	1.3 2.0 1.3 1.3	30 *40 10 25	50 50 50	- *40 *25 65	0.001 15 0.001 0.1	*6.0 *20 *6.0 *5	- .25 0.08 0.06	18 5 5 18	M. Pair 2N2185; CT, SPR *PH orig Reg, CT *PH orig Reg, CT
	2N2278 2N2279	*SPR +SPR	pnp,SP,si pnp,SP,si	*7.6 *7.6	150 150	140 140	1.3 1.3	15 15	50 50	-	0.001 0.001	*6.0 *6.0	-	18 18	Chopper *PH orig Reg, CT M Pair 2N2278 † PH Orig Reg,
	2N3318 2N414	SPR RCA	pnp,SP,si pnp, AJ, ge	*7.6 8	150 150	140 85	1.3	15 *30	50 200	- 80	.001	*9 *11	-	18 5	CT Chopper LAN
LL 10	2N521 2N521A 2N579 2N581 2N583	GI GI RCA	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	8 8 8 8	100 150 120 150 150 120	85 100 71 85 85	1.67 2.0 - -	*15 *20 *20 *18 *18	- 400 100 100	35 70 *30 30 *30	2 2 5 3 3	*14 *14 - -	- 0.2 0.2 0.2	5 5 9 5	TI, IND GI, IND GI, TI, LAN, IND GI, LAN
	2N862 2N2970 2N2971 2N358 2N358A	*SPR SPR SPR GI	pnp,SP,si pnp,SP,si pnp,SP,si npn,AJ,ge npn,AJ,ge	*8 *8 *8 9	150 150 150 100 150	140 140 140 85 100	1.3 1.3 1.3 2.0 2.0	15 *30 *30 *20 *30	50 50 50 -	33 *10 *10 *20-50 *25-75	0.1 0.01 0.01 5 5	*5 *6.0 *6 *14 *14	0.07 0.08 0.08 .20 .20	18 5 18 5 5	*PH orig Reg, CT Symmetrical Symmetrical TI TI
LL 11	2N428 2N863 2N942 2N2165 2N2166	*SPR SSD SPR SPR	npn,AJ,ge pnp,SP,si AJ pnp,SP,si pnp,SP,si	10 *10 10 *10 *10	150 150 250 150 150	100 140 175 140 140	2.5 1.3 1.67 1.3 1.3	*30 15 8 30 15	400 50 50 50 50 50	*60 65 *25 -	25 0.1 .0025 0.020 0.020	*20 *5 *14 *6 *6	.32 0.06 .004 -	5 18 18 5 5	*PH orig Reg CT, Chopper Pairs, SPR Chopper, CT Chopper, CT
	2N2944 2N2968 2N2969 2N2677 40346	CT SPR SPR GE RCA	pnp,si pnp,SP,si pnp,SP,si npn,DG,si npn,si	*10 *10 *10 *10 *10	400 150 150 250 5W	200 140 140 175 200	2.3 1.3 1.3 1.66 28.5	*15 *30 *30 *45	100 50 50 25 0.5A	*80 *15 *15 *20-55 *20 (min)	.0001 0.01 0.01 .1 *5	*10 *6 *6 *3	- 0.06 0.06 1.5 0.5	46 5 18 46 5	Symmetrical Symmetrical VCER = 175
LL 12	TW-135 2N316 2N316A 2N3019 2N3020	SPR GI GI FA FA	pnp, PE,si pnp, AJ,ge pnp, AJ,ge npn, DPE,si npn, DPE,si	10 12 12 12 12 12	400 100 150 800 800	200 85 100 200 200	2.4 2.0 2.0 28.6 28.6	30 *20 *25 *140 *140	100 200 200 100 100	*50 *20-50 *20-50 5 4	0.001 2 2 -	*9 *14 *14 12 12	0.15 .18 .18 0.2 0.2	18 5 5 5 5	Complementary to 2N2432 IND IND
	2N3319 2N2162 2N2163 2N337A 2N522	SPR SPR SPR GE GI	pnp,SP,si pnp,SP,si pnp,SP,si npn,DG,si pnp,AJ,ge	*12 *14 *14 *15 15	150 150 150 500 100	140 140 140 175 85	1.3 1.3 1.3 3.33 1.67	*10 30 15 *45 *15	50 50 50 20	- 35 35 *20-55 60	50 0.001 0.001 .5 2	*10 *6 *6 *3 *14	- - 1.5 -	18 5 5 5 5	Chopper Chopper, CT Chopper, CT TR TI
LL 13	2N522A 2N580 2N1276 2N1277 2N1278	GE GE GE	pnp,AJ,ge pnp,AJ,ge npn,DG,si npn,DG,si npn,DG,si	15 15 *15 *15 *15	150 120 150 150 150	100 71 150 150 150	2.0 - 1.2 1.2 1.2	*20 *20 *40 *40 *40	- 400 25 25 25 25	100 *45 9-22 18-44 37-90	2 5 1 1	*14 - *5 *5 *5	- 0.2 1 1	5 9 5 5 5	TI, IND GI, IND TR TR TR
	2N1279 2N1309A 2N2349 2N3677 2N864	GE GI GE CT *SPR	npn,DG,si pnp,AJ,ge npn,DG,si EP,si pnp,SP,si	*15 15 *15 *15 *16	150 150 150 400 150	150 85 150 200 140	1.2 2.5 1.25 2.3 1.3	*40 *35 *40 *30 6	25 300 25 100 50	76-333 *80 *120-250 - 65	1 6 1 0.001 0.1	*5 20 *4 *10 *5	1 . 0.2 1.5 - 0.06	5 5 18 18	TR TI Low Rec (SAT) Chopper *PH orig Reg, CT
LL 14	2N941 2N1676 2N1677 2N2167 2N2280	SSD *SPR *SPR SPR *SPR	AJ pnp,SAT,si pnp,SAT,si pnp,SP,si pn p,SP,si	16 *16 *16 *16 *16	250 100 100 150 150	175 140 140 140 140	1.67 0.87 0.87 1.3 1.3	8 4.5 4.5 *12 *10	50 50 50 50 50	*25 _ 50 _ _	.0025 0.001 0.001 0.002 0.003	*14 *7 *7 *6 *7	.002 0.04 0.055 - 0.05	18 5 5 5 18	CT, Chopper Pairs, SPR Chopper, *PH orig Reg Chopper, *PH orig Reg Chopper, CT Chopper, *PH orig Reg, CT

(see pages 4-9 for explanation of company abbreviations.)

May 17, 1966 79

Low-Level (continued)

					M	AX. RAT			(HARACTI	ERISTICS				
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (MHz)	P _c (mW)	T _j (°C)	mW/°C	*VCEO *VCBO (V)	I _C (mA)	h _{fe} *h	Ι _{C0} *Ι _{CE0} (μΑ)	C _{oe} *C _{ob} (pF)	V _{ce(sat)}	Package Outline (TO-)	Remarks
LL 15	2N2281 2N582 2N317 2N317A 2N1384	RCA GI GI RCA	pnp, SP, si pnp, AJ, ge pnp, AJ, ge pnp, AJ, ge pnp, DR, ge	*16 18 20 20 *20	150 150 100 150 240	140 85 85 100 85	1.3 - 2.0 2.0 -	*10 *25 *20 *25 *30	50 100 400 400 500	- 60 *20-60 *20-60 *20	0.003 2 2 2 2 4	*7 - *14 *14 -	- 0.2 .20 .20	18 5 5 5 11	Matched 2N2280's, SPR, CT GI, TI, RCA, IND TI, IND TI, IND
	2N2350 2N2351 2N2352 2N2353 2N2678	GE GE GE GE	npn, PL, si npn, PL, si npn, PL, si npn, PL, si npn, DG, si	20 20 20 20 20 *20	400 400 400 350 250	200 200 200 200 200 175	2.3 2.3 2.3 - 1.66	40 50 40 25 *45	1 1 1 1 25	*300 *120 *60 *20 45-150	- - - .1	20 20 20 20 20 *3	0.35 0.35 0.35 0.35 1.5	46 46 46 46 46	
11.10	UD-1000 2N523 2N523A 2N865 2N2164	SPR GI GI *SPR SPR	npn,PE,si pnp,AJ,ge pnp,AJ,ge pnp,SP,si pnp,SP,si	20 21 21 *24 *24	200 100 150 150 150	200 85 85 140 140	1.1 1.67 2.0 1.3 1.3	20 *15 *15 *10 *12	20 - - 50 50	80 125 150 40	0.010 2 2 0.1 0.002	*10 *14 *14 *5 *6	- - 0.05	90 5 5 18 5	Twin Dual IND *PH orig Reg, CT Chopper, CT
LL 16	2N338A 2N524A 2N842 2N1060 2N525A	GE MO TR	npn,DG,si pnp,AJ,ge npn,PE,si npn,DM,si pnp,AJ,ge	25 25-42 30 30.0 34-65	500 225 300 350 225	175 100 175 150 100	3.33 6.67 2 2.0 6.67	45 *45 45 40 *45	25 500 50 50 50	45-150 18-41 *20-55 20 30-64	.5 10 1 0.1 10	3 *40 10 *10 *40	1.5 0.130 1.2 0.3 0.130	5 5 18 18 5	TR NA
11 17	2N794 2N843 2N1300 2N1854 2N1683	TR RCA RCA RCA	pnp,MS,ge npn, PE, si pnp,MS,ge pnp, DM, ge pnp,MS,ge	40 40 *40 40 *50	150 300 150 150 150	85 175 85 85 85	2	*13 45 *13 *18 12	100 50 100 100 100	*50 *45-150 30 40-400 *50	13 1 3 4.2 3	*10	1. 2 0. 25	18 18 5 5 5	SPR SPR, TI TI, SPR
LL 17	TN-79 TN-80 2N526A 2N795 2N1301	SPR SPR MO RCA	npn, PE, si npn, PE, si pnp, AJ, ge pnp, MS, ge pnp, MS, ge	50 50 53 - 90 60 *60	800 500 225 150 150	200 200 100 85 85	4.57 2.86 6.67 -	*30 *30 *45 *13 *13	800 800 500 100 100	*100 *100 44-88 *75 30	0.010 0.010 10 13 3	*10 *10 *40 -	C.130	5 18 5 18 5	DC/AC Chopper DC/AC Chopper SPR SPR, TI
	\$18200 2N398A 2N3107 2N3109 2N3340	FA MO FA FA SSD	npn,DPE,si pnp,AJ,ge npn,DPE,si npn,DPE,si npn,PL	60 65 70 70 *70	.4 150 800 800 400	200 100 200 200 200 200	11.4 2 4.57 4.57 2.28	60 105 100 80 20	500 200 1000 1000 30	300 *65 60 60 *60	- 12 .01 .01 0.001	20 - 20 25 *6	.25 .11 10 150 0.2	50 5 5 5 46	GI, TI, RCA
LL 18	2N3341 2N527A 2N796 2N1131A 2N1132A	MO HU	pnp, EP pnp,AJ,ge pnp,MS,ge pnp pnp	*70 72-121 80 *80 *80	400 225 150 750 750	200 100 85 175 175	2.28 6.67 - -	20 *45 *13 *60 *60	30 500 100 -	*60 60-120 *85 *30 *60	0.01 10 13 -	*6 *40 - -	0. 25 0.130 - -	46 5 18 5 5	SPR MO
	2N1132B 2N1252 2N3108 2N3110 2N1139	HU FA FA FA TR	pnp npn,DD,si npn,DPE,si npn,DPE,si npn,PE,si	*80 *80 96 96 100	750 2.0 800 800 500	175 175 200 200 175	- 13.3 4.57 4.57 6.6	*70 *30 100 80 15	- 1000 1000 100	*60 *35 40 40 *20-200	- 0.1 .01 .01 5	*30 20 25 12	- 0.6 10 150 .7	5 5 5 5 5	MO SY, AL, NA
LL 19	2N1254 2N1255 2N1256 2N1257 2N1257 2N1258	HU HU HU HU	pnp pnp pnp pnp pnp	*100 *100 *100 *100 *100	275 275 275 275 275 275	175 175 175 175 175 175		30 30 40 40 30	-	30 *60 *30 *60 *100		8 8 8 8		5 5 5 5	
	2N1259 2N1444 2N2102 2N2569 2N2570	HU RCA AMP AMP	pnp npn, DM, si npn,si npn,PE,si npn,PE,si	*100 100 *100 100 100	275 500 5W 300 300	175 150 200 175 175	- 4 28.6 2 2	50 *60 65 *20 *20	250 1a 100 100	*50 *25 *40-120 *50 *50	- 0.5 .002 .01	8 *32 *75 *10 *10	- 1.5 0.5 0.2 0.2	5 5 5 18 18	NA CDC, GI, TR, TRWS Chopper - Vottset=145 Chopper - Voffset=350
LL 20	2N3883 3N71 3N72 3N73 FT34C	MO SSD SSD SSD FA	pnp,EM,ge n,PL n,PL n,PL npn,DPE,si	*100 *100 *100 *100 100	750 100 100 100 100 800	100 200 200 200 200 200	10 .57 .57 .57 .0286	15 *15 *15 *15 *15	300 10 10 10	*30 *40 *40 *40 *120	.010 .010 .010	*8 *6 *6 *6	0.5 50 100 200 1	5 18 18 18 18 5	Ices =100 Dual-Emitter Chopper Dual-Emitter Chopper Dual-Emitter Chopper
	FT34D MCS2135 MCS2136 MCS2137 MCS2138	FA MO MO MO MO	npn,DPE,si npn,AE,si npn,AE,si pnp,AE,si pnp,AE,si	100 *100 *100 *100 *100	800 150 150 150 150	200 125 125 125 125 125	.0286 1.5 1.5 1.5 1.5	120 60 60 60 60	50 50 50 50	*300 *100-300 *250-750 *100-300 *250-750	- .01 .01 .02 .02	- *3 *3 *3 *3	1 0.3 0.3 0.2 0.2	5 - - -	
LL 21	2N1204 2N1204A 2N1253 2N1494 2N1494A	MO MO FA MO MO	pnp, EP, ge pnp, EP, ge npn, DD, si pnp, EP, ge pnp, EP, ge	*110 *110 *110 *110 *110 *110	750 750 2.0 750 750 750	100 100 175 100 100	10 10 13.3 10 10	15 15 *30 15 15	500 500 - 500 500	*15 *25 *45 *15 *25	7 7 0.1 7	*6.5 *6.5 *30 *6.5 *6.5	0. 4 0. 4 0.6 0. 4 0. 4	5 5 5 31 31	GI, AL, NA

						M	AX. RAT	INGS		(CHARACTE	RISTICS			
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (MHz)	P c (mW)	T _j (°C)	mW/°C	V CEO *V CBO (V)	1 _C (mA)	h _{fe} *h	Ι _{CO} *Ι _{CEO} (μΑ)	C _{oe} *C _{ob} (pF)	V _{ce(sat)}	Package Outline (TO-)	Remarks
LL 22	2N2800 2N2801 40366 2N1754 S18100	MO MO RCA *SPR FA	pnp,AE,si pnp,AE,si npn,si MADT,ge npn,DPE,si	*120 *120 *1 20 *125 130	3W 3W 5W 50	200 200 200 85 200	1.73 17.3 28.5 - 11.4	35 35 65 *13 *60	800 800 1 A 100 500	*30 - 90 *17 - 225 *40-1 20 *75 150	†0.1 †0.1 2 nA .6	*25 *25 *15 *1.5	.4 .4 0.5 .12 .25	5 5 5 9 50	†Icex †Icex High-Reliability type GI, *PH orig. Reg.
LL 22	2N702 2N703 2N1495 2N1496 2N2330	TI TI MO MO MO	npn,si npn,si pnp, EP, ge npn, EP, ge npn, AE, si	*150 *150 *150 *150 *150	300 300 750 750 3w	175 175 100 100 175	2 2 10 10 20	25 25 25 25 25 20	50 50 500 500	*20 *40 *25 *25 50/-	0.5 0.5 7 7 0.001	*3 *6.5 *6.5 *10	0.5 0.5 0.3 0.3 0.001	18 18 5 31 5	TRWS, GI, NA TRWS, FA, SY, GI, NA SPR
11.00	2N2331 2N3554 2N1499 2N1708 2N2205	MO TI PH RCA RCA	npn,AE,si npn,EP,si pnp,ge npn,PE,si npn,PE,si	*150 *150 *160 *200 *200	1.8W 800 60 300 300	175 200 100 175 175	12 4.57 - - -	20 30 *20 *25 *25	1200 100 200 200	50 *25-100 *70 *20 *20	0001 0.5 .6 12 0.025	*10 *25 *1.5 *6 *6	0.001 0.7 .12 0.22 0.22	18 5 9 46 18	SPR FA,SY, GI SY, RCA
LL 23	2N2206 2N3485 2N3485A 2N3486 2N3486A	RCA FA FA FA FA	npn,PE,si pnp,PE,si pnp,PE,si pnp,PE,si pnp,PE,si	200 200 200 200 200 200	300 360 2000 2000 2000	175 200 200 200 200 200	11.4 11.4 11.4 11.4	*25 40 40 40 40	- 600 600 600 600	*40 40-120 40-120 100-300 100-300	0.025 .020 .020 .020 .020	6 8 8 8	0.22 0.4 0.4 0.4 0.4	46 46 46 46 46	SY
LL 24	2N3644 2N3645 2N3905 2N4125 40218	FA FA MO MO RCA	npn,DPE,si pnp,DPE,si pnp,AE,si pnp,AE,si npn,MS,si	200 *200 *200 *200 *200 *200	700 700 310 310 300	125 125 135 135 135 175	7.0 7.0 2.81 2.81 2	45 60 40 30 *25	500 500 200 200 200 50	200 *200 *50-150 *50-150 *20-60	- + .05 0.5 (max)	4.5 4.5 *4.5 *4.5 5 (max)	- 0.25 0.4 0.6 (max	- 92 92 92) 52	
LL 24	40222 FK3299 MPS706 UD-3005 UD-3006	RCA FA MO SPR SPR	npn,PE,si npn,DPE,si npn,EP,si npn,PE,si npn,PE,si	*200 200 *200 200 200 200	300 175 500 350 350	175 200 125 200 200	2 2 5 -	*25 30 *25 60 60	200 20 - 600 600	*20 (min) 40-120 *20 *100-300 *100-300	.025 (max .15 0.5 0.010 0.010	() 6 (max) 8 *6 *8 *8	.22 (max .22 0.6 0.4 0.4	52 - 92 85 85	Hermet package npn Quad pnp Quad
II. or	UD-3007 2N827 2N2048 2N2475 2N2476	SPR MO *SPR RCA RCA	npn,PE,si pnp,DM,ge MADT,ge npn,PE,si npn,PE,si	200 *250 *250 250 250	350 150 150 600 600	200 100 100 200 200	2	60 *20 15 *60 *60	600 100 100 - -	*100-300 *100 *125 *20 *40	0.010 5 1 0.2 0.2	*8 9 *1.5 *10 *10	0.4 0.25 .13 0.4 0.4	85 18 9 5	Complementary Quad TI *PH orig. Reg. SPR
LL 25	2N3015 2N3250 2N3641 2N3642 2N3643	FA FA FA FA	npn,EP,si pnp,DPE,si npn,PE,si npn,PE,si npn,PE,si	*250 250 *250 *250 *250 *250	800 360 700 700 700	200 200 125 125 125	4.57 6.9 7.0 7.0 7.0	30 *50 30 45 30	200 - - -	*30-120 150 *75 *75 *220	0.2 - 0.05 0.5 0.5	*8 .25 *6.0 *6.0 *6.0	0,4 0,25 0,35 0,35 0,35	5 18 - -	TI, SPR CDC, IEC, GME CDC, IEC, GME CDC, IEC, GME
11.00	2N3903 2N3906 2N3946 2N4123 2N4126	MO MO MO MO	npn,AE,si pnp,AE,si npn,AE,si npn,AE,si pnp,AE,si	*250 *250 *250 *250 *250 *250	310 310 1200 310 310	135 135 200 135 135	2.81 2.81 6.9 2.81 2.81	40 40 40 30 25	200 200 200 200 200 200	*50-150 *100-300 *50-150 *50-150 *120-360	† † .05 .05	*4 *4.5 *4 *4 *4.5	0.2 0.25 0.2 0.3 0.4	92 92 18 92 92	
LL 26	FK3300 FK3502 FK3503 FV3503 MPS2713	FA FA FA MO	npn,DPE,si pnp,DPE,si pnp,DPE,si pnp,DPE,si npn,AE,si	250 250 250 250 250 *250	175 175 175 175 175 310	200 200 200 200 200 135	2 2 2 2 2 2.81	30 45 60 60 18	20 500 500 500 200	100-300 300 300 300 300 *30-90	.15 10 10 10 0.5	8 8 8 *2.5	.22 .25 .25 .25 .25	- - 51 92	Hermet package Hermet package Hermet package
11.07	MPS2714 NS1110 NS1111 NS1500 NS1510	MO NA NA NA NA	npn,AE,si npn,PL,si npn,PL,si npn,PL,si npn,PL,si	*250 250 250 *250 *250 *250	310 500 500 500 500 500	135 200 200 200 200 200	2.81 3 3 25 2.5	18 110 60 20 20	200 100 100 100 100	*75-225 - - *50-100 *50-100	0.5 1 .1 0.5 0.5	*2.5 *6 *6 5 3.8	0.3 - - .1	92 18 18 18 18	Avalanche Transistor Avalanche Transistor
LL 27	2N784A 2N835 2N838 2N914/46 2N2381	SY MO MO SY MO	npn,EO,si npn,EP,si pnp,EM,ge npn,PL,EP,si pnp,EM,ge	300 *300 *300 300 *300	360 1W 150 400 750	200 175 100 200 100	- 6.67 2 - 10	*40 *25 *30 *40	200 200 100 - 500	*25-150 20 *30 *30-120 *40	.025 0.01 10 .025	3.5 *2.8 4 *6 *3.5	.65 30 0.18 0.7 .25	18 18 18 46 5	ITT, SPR GI
	2N2382 2N2717 2N3131 2N3251 2N3605	MO AMP NA FA GE	pnp,EM,ge pnp,AD,ge npn,si pnp,DPE,si npn,PEP,si	*300 300 *300 300 300	750 275 200 360 200	100 75 175 200 100	10 0.50 - 6.9 2.67	20 *20 15 *50 14	500 300 100 200 200	*40 *50 *30-120 300 *65	1 - .025 - 0.5	*3.5 - *4 .25 *4.8	.25 0.35 .25 0.25 .25	5 18 - 18 98	
LL 28	2N3606 2N3607 2N3904 2N3947 2N4124	GE GE MO MO MO	npn,PEP,si npn,PEP,si npn,AE,si npn,AE,si npn,AE,si	300 300 *300 *300 *300	200 200 310 1200 310	100 100 135 200 135	2.67 2.67 2.81 6.9 2.81	14 14 40 40 25	200 200 200 200 200 200	*65 *65 *100-300 *100-300 *120-360	0.5 0.5 † *	*4.8 *4.8 *4 *4 *4	.25 .25 0.2 0.2 0.3	98 98 92 18 92	

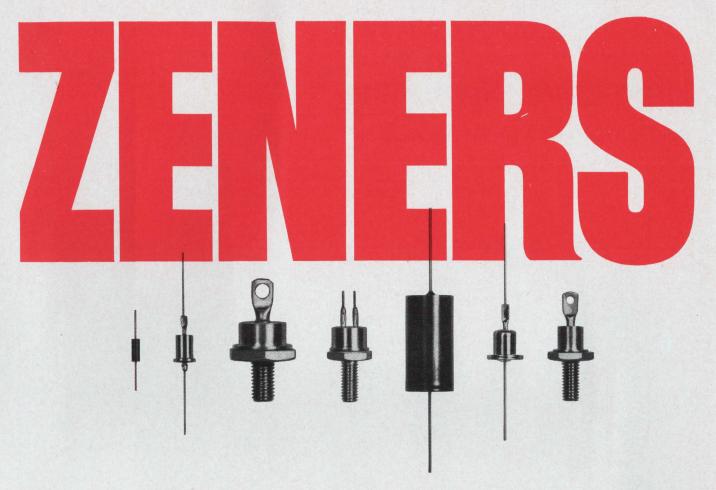
(see pages 4-9 for explanation of company abbreviations.)

May 17, 1966 81

						M	AX. RA			(CHARACT	ERISTICS			
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (MHz)	P _c (mW)	T _j (°c)	m₩/°C	*VCEO *VCBO (V)	l C (mA)	hfe *hFE	C0 * CE0 (μΑ)	C _{oe} *C _{ob} (pF)	V _{ce(sat)}	Package Outline (TO-)	Remarks
LL 29	2N4264 2N4265 40219 40221 MM709	MO MO RCA RCA MO	npn,AE,si npn,AE,si npn,PL,si npn,PE,si npn,AE,si	*300 *300 *300 *300 *300	310 310 360 360 750	135 135 200 200 200	2.81 2.81 2.06 2.06 4.3	15 12 *40 *40 8	200 200 - - 100	*40 - 160 *100 - 400 *30-120 *30-120 *15-120		*4 *4 () 6 (max) () 6 (max) *3	0.22 0.22 0.4 (max) 0.7 (max) 0.35	92 92 52 52 52 52	
LL 23	2N2256 2N2257 2N2258 2N2259 2N834	MO MO MC MO MO	npn,ME,si npn,ME,si pnp,ME,ge pnp,ME,ge npn,EM,si	*320 *320 *320 *320 *320 350	1000 1000 300 300 1 W	175. 175 100 100 175	6.67 6.67 4 6.67	7 7 7 7 *40	100 100 100 100 200	*30 *50 - 25	3 3 3 0.01	*4 *4 *4 *4 *2.8	- - - - 0.25	18 18 18 18 18	FA, SY, TR, GI, NA, ITT, SPR
LL 30	2N3009 2N3647 2N3973 2N3974 2N3975	FA FA GE GE GE	npn,EP,si npn,DPE,si npn,PEP,si npn,PEP,si npn,PEP,si	*350 350 *350 *350 *350	360 400 360 360 360	200 200 150 150 150	2.06 11.43 2.67 2.67 2.67	15 10 *60 *60 *60	200 500 400 400 400	*30-120 25-150 *35-100 *55-200 35-100	0.5 - 0.5 0.5 0.5	*5.4 *5.2 *5.2 *5.2	0.18 0.4 0.3 0.3 0.3	18 46 98 98 98	ті
22 30	2N3976 40220 MPS834 MPS3646 2N706	GE RCA MO MO FA	npn,GE,si npn,PE,si npn,EP,si npn,AE,si npn,DD,si	*350 *350 *350 *350 *400	360 300 500 500 1.0	150 175 125 125 175	2.67 2 5 5.0 6.7	*60 *40 30 15 *25	400 200 200 200 200	55-200 *25 (min) *25 *30-120 *45	0.5 0.5 (max) 0.5 † 0.005	*5.2 4 (max) *4 *5 *5	0.3 .25 (max) 0.25 0.2 0.3	98 52 92 92 18	tlces=0.5 SY,MO,TR,GI,AMP,ITT,SPR, RCA,MO,NUC
	2N706A	TI	npn,si		300	175	2	20	50	*20	10	*5	0.6	18	FA, SY, TR,,GI, ITT, GE, MO, RA, RCA
LL 31	2N706B 2N707	MO FA	npn,EP,si npn,DD,si	*400 *400	300	175 175	6.7	*25 *56	500	*12	0.005	*5 *5	.3 0.3	18 18	FA, SY, GI, TR, ITT TRWS, MO, GI
LL 31	2N708 2N742	FA NA	npn,DP,si npn,si	*400	1.2	200	6.9	15 25	100	*50 *25	0.004	*4	0.3	18 18	SY, MO, TR, GI, AMP, ITT, RCA, MO, NA, NUC
	2N828 2N2537	MO MO	pnp,EM,ge npn,AE,si	*400 *400	300 3W	100 200	4 17.2	15 30	200	*40 *50-150	.4 .25	*3.5 *8	.18	18 5	SY. RCA. TI, LAN SPR, GI, SY, NA
	2N2538 2N2539 2N2540 2N3011 2N3012	MO MO MO TI FA	npn,AE,si npn,AE,si npn,AE,si npn,EP,si pnp,EP,si	*400 *400 *400 *400 *400	3W 8W 1.8W 360 360	200 200 200 200 200 200	17.2 10.3 10.3 2.06 2.06	30 30 30 12 12	- - 200 200	*100 - 300 50 - 150 *100 - 300 *30 - 120 *30 - 120	.25 .25 .25 0.4 0.08	*8 *8 *8 *4 *6	.45 .45 .45 0.2 0.15	5 18 18 18	SPR, GI, SY, NA SPR, GI, NA SPR, GI, NA TI
LL 32	2N3493 2N3576 2N3722 2N3723 40217	MO TI FA FA RCA	npn,EA,si pnp,EP,si npn,PE,si npn,PE,si npn,MS,si	*400 *400 400 400 *400	250 360 800 800 300	200 175 200 200 175	1.43 2.4 22.8 22.8 2	8 15 60 80 *25	200 500 500	*40-120 *40-120 - - *20 (min)	†.005 0.01 - - 0.5 (max)	*4.5 9.0 9.0 5	0.15 .75 .75 0.3	18 5 5 5 52	†Icex
	MPS2894 2N3648 2N4046 2N4047 2N960	MO FA FA FA MO	pnp,EP,si npn,DPE,si npn,PE,si npn,PE,si pnp,EM,ge	*400 450 450 450 450 *460	1000 400 .8 .8 .8	125 200 200 200 200 100	10 11.43 20 20 4	12 15 50 50 *15	500 500 500 500	*40-150 30-120 *150 *150 *40	.08 - - - - .4	*6 4 12 10 *2.2	0.15 0.4 .75 .95 0.13	92 46 5 5	RCA
LL 33	2N961 2N964 2N965 2N966 MPS3639	MO MO MO MO	pnp,EM,ge pnp,EM,ge pnp,EM,ge pnp,EM,ge pnp,EP,si	*460 *460 *460 *460 *500	300 300 300 300 500	100 100 100 100 100 125	4 4 4 4 5	*12 *15 *12 *12 6	- - - - 80	*40 *70 *70 *70 *30-120	.4 .4 .4 .4	*2.2 *2.2 *2.2 *2.2 *3.5	.13 .11 .11 .11 0.16	18 18 18 18 18	RCA RCA RCA RCA Hcs==.01
	MPS3640 2N1195 2N2368 2N3646 2N4121	MO FA FA FA	pnp,EP,si pnp,DM,ge npn,PE,si npn,PE,si pnp,DPE,si	*500 *550 *550 550	500 250 1200 500 200	125 100 200 125 125	5 3.33 6.85 5.0 5	12 *30 15 15 40	80 40.0 500 - 100	*30-120 13.0 *40 *60 200	† 2.0 0.1 0.4	*3.5 4.0 *2.5 *3.3 4.5	0.2 0.54 0.2 0.39	92 5 18 - -	tices =.01 TI, MO TR, AL, MO, SPR ICE, GME R0110 package
LL 34	2N 1992 2N 2475 2N 3010 2N 3640 2N 4122	RCA FA FA FA	npn,D,si npn,PE,si npn,EP,si pnp,PE,si pnp,DPE,si	*600 *600 *600 *600 600	350 500 300 500 200	150 200 200 200 125 125	2 - 1.71 5. 0 5	15 *15 6 12 40	50 - 50 - 100	*45 - *25-125 *63 300	.5 0.002 0.1 0.00005	*5 *2.1 *3 *1.85 4.5	.25 0.26 0.25 0.18	18 18 52 -	NA TI IEC, GME R0110 package
11.00	2N2369 2N2369A 2N2787 2N2788 2N2789	FA FA GI GI GI	npn,PE,si npn,PE,si npn,si npn,si npn,si	*650 *675 *700 *700 *700	1200 1200 800 800 800	200 200 175 175 175	6.85 6.85 5.33 5.33 5.33	15 15 35 35 35 35	500 200 - - -	*80 *65 *20-60 *40-120 *100-300	0.1 0.05 .01 .01	*2.5 *2.3 *8 *8 *8	0.2 0.14 0.4 0.4 0.4	18 18 5 5 5	TR, MO, AL TR, AL, SPR STC, SPR STC, SPR STC, SPR
LL 35	2N2790 2N2791 2N2792 2N709 2N917	GI GI FA FA	npn,si npn,si npn,si npn,PE,si npn,DP,si	*700 *700 *700 *800 *800	500 500 500 0.5 0.3	175 175 175 200 200	3.33 3.33 3.33 5 1.71	35 35 35 6 15	- - - - -	*20-60 *40-120 *100-300 *55 50	.01 .01 .01 0.005 0.0005	*8 *8 *8 *2.5 *1.5	0.4 0.4 0.4 0.21 0.4	18 18 18 18 18	STC, SPR STC, SPR STC, SPR SY, AL, TI, TR, VEC TI, RCA, AL, TRWS

						MA	X. RAT	INGS		С	HARACTE	RISTICS	Training and the		
Cross Index Key	Type No.	Mfr.	Туре	fae *f T (MHz)	P _c (mW)	T _j	m₩/°C	V CEO *V CBO (V)	C (mA)	h _{fe} *hFE	l _{CO} *l _{CEO} (μA)	C _{oe} *C _{ob} (pF)	V _{ce(sat)}	Package Outline (TO-)	Remarks
LL 36	V-120 2N918 2N955A MM2550 MM2552	VEC FA RCA MO MO	npn,PE,si npn,PE,si npn, DD, ge pnp,EP,DJ,ge pnp,EP,DJ,ge	*800 *900 *1000 *1000 *1000	- 0.3 150 300 600	200 200 100 100 100	- 1.71 - 4 8	*15 15 *12 10 10	50 150 100 100	*110 *50 *50 *20 *30	.00009 0.0002 0.6 10 10	*2.1 *1.4 *4 *3 *3	.12 0.12 0.22 0.2 0.2	18 18 18 18 5	MO, TI, RCA, AL, TRWS, VEC
22 30	MM2554 2N3959 2N3960 2N4260 2N4261	MO MO MO MO	pnp,EP,DJ,ge npn,AE,si npn,AE,si pnp,AE,si pnp,AE,si	*1000 *1300 *1600 *1600 *2000	600 750 750 200 200	100 200 200 200 200 200	8 4.3 4.3 1.14 1.14	10 12 12 15 15	100 30 30 30 30 30	*30 *40-200 *40-200 *30 - 150 *30 - 150	10 0.1 0.1 †.005 †.005	*3 *2.5 *2.5 *2.5 *2.5	0.25 0.2 0.2 0.35 0.35	5 18 18 72 72	
LL 37	BSY 62 2N284 2N284A 2N337 2N338	SA AMP AMP TI TI	npn,EP,PL,si pnp,AJ,ge pnp,AJ,ge npn,si npn,si	*20000 - - - -	0 860 125 125 125 125 125	175 75 75 150 150	7 2.5 2.5 1 1	15 32 60 *45 *45	200 125 125 20 20	20-60 *45 *45 66 99	0.5 4.5 4.5 1	5 - *1.2 *1.2	0.6 0.4 0.4 -	18 1 1 5 5	GE, TR GE, TR
LL 3/	2N398 2N586 2N705 2N707A 2N710	RCA TI TI TI	pnp,AJ,ge pnp,AJ,ge pnp,ge npn,si pnp,ge	11111	50 250 150 500 300	55 85 100 175 100	- 2 3.33 4	105 *45 *15 40 *15	100 250 50 100 50	*20 30 *40 *9 *40	14 12 0.3 1 3	- *5 *6 -	0.35 0.25 0.3 0.6 0.5	5 7 18 18 18	MO, GI , TI, RCA SY, MO, RCA MO, GI SY, RCA
	2N711 2N711A 2N711B 2N725 2N744	TI TI TI TI	pnp,ge pnp,ge pnp,ge pnp,ge npn,si	1111	150 150 150 150 150 300	100 100 100 100 100 175	2 2 2 2 2 2	*12 7 7 *15 12	100 100 100 50 200	1.5 *40 *40 *20 *40	3 1.5 1.5 3 1	*7.5 *6 *6 *5 *5	0.5 0.30 0.25 - 0.35	18 18 18 18 18	SY, MO, AMP, RCA SY, MO SY, MO FA, SY, MO, TR, GI, ITT
LL 38	2N781 2N782 2N797 2N849/TI- 2N850/TI-		pnp,EP,ge pnp,EP,ge npn,ge npn,si npn,si	1111	300 300 150 300 300	100 100 100 175 175	- 2 2 2 2	*15 *12 7 15 15	200 200 150 50	*25 *20 *40 *20 *40	3 3 1 0.5 0.5	- *4 *5 *5	0.2 0.2 0.14 0.6 0.6	18 18 18 50 50	AL
	2N851/TI4 2N852/TI4 2N985 2N999 2N1216		npn,si npn,si pnp,ge npn,DP,si pnp,MS,ge	1 1 1 1	300 300 150 500 75	175 175 100 200	2 2 2 10.3	12 12 7 60 *25	200 200 200 500 100	*20 *40 *60 -	- 3 0,0001	*5 *5 *6 *15	0.35 0.35 0.15 1.2	50 50 18 18 5	мо
LL 39	2N1228 2N1229 2N1230 2N1231 2N1232	HU HU HU HU	pnp pnp pnp, pnp pnp	1111	400 400 400 400 400	160 160 160 160 160		15 15 35 35 60		20 40 20 40 20	.1 .1 .1 .1	-	.2 .2 .2 .2 .2	5 5 5 5 5	SPR, AMP, CT SPR, AMP, CT SPR, AMP, CT SPR, AMP, CT SPR, AMP, CT
	2N1233 2N1234 2N1302 2N1303 2N1304	HU HU TI TI TI	pnp pnp npn,ge pnp,ge npn,ge	1111	400 400 150 150 150	160 160 85 85 85	- 2.5 2.5 2.5 2.5	60 110 *25 *30 *25	- 300 300 300	40 20 *20 *20 *40	.1 .1 6 6 6	- *20 20 20	.2 .2 0.2 0.2 0.2	5 5 5 5 5	SPR, AMP, CT SPR, AMP, CT AMP, GE, RCA, NUC AMP, GI, RCA, NUC AMP, GI, RCA, NUC
LL 40	2N1305 2N1306 2N1307 2N1308 2N1309	TI TI TI TI	pnp,ge npn,ge pnp,ge npn,ge pnp,ge	1 1 1 1	150 150 150 150 150	85 85 85 85 85	2.5 2.5 2.5 2.5 2.5 2.5	*30 *25 *30 *25 *30	300 300 300 300 300	*40 *60 *60 *80 *80	6 6 6 6	20 20 20 20 20 20	0.2 0.2 0.2 0.2 0.2	5 5 5 5	AMP, GI, RCA, NUC AMP, GI, RCA, NUC AMP, GI, RCA, NUC AMP, GI, RCA, NUC AMP, GI, RCA, NUC
	2N1404 2N1404A 2N1507 2N1510 2N1853	TI TI TI GE RCA	pnp,ge pnp,ge npn,si npn, GR,ge pnp, DM, ge	1111	150 150 600 75 150	85 85 175 85 85	2.5 2.5 4 1.25	*25 *25 *60 *75 *18	300 300 1a 20 100	*30 *100 *30 30-400	5 5 1 0.5 4.2	*20 *20 *35 -	0.15 0.15 1.5 0.26 0.2	5 5 5 - 5	CDC, AL
LL 41	2N1917 2N1918 2N1919 2N1920	SSD SSD SSD	LA LA LA LA	- - -	250 250 250 250	175 175 175 175	1.67 1.67 1.67	8 8 18	50 50 50 50	*25 *25 -	.002 .006 .002	*14 *14 *14	.002 .004 .003	5 5 5	TRWS, CT, Chopper Pairs, SPR Chopper Pairs, CT, SPR TRWS, AMP, CT, Chopper Pairs, SPR TRWS, AMP, CT, Chopper Pairs,
	2N1921	SSD	AJ	-	250	175	1.67	50	50	-	.004	*14	.005	5	TRWS, AMP, CT, Chopper Pairs,
11	2N1922 2N1994	SSD TI	AJ npn,ge	-	250 150	175 85	1.67 2.5	80 15	50 300	*15	.004	*14 *20	.005 0,25	. 5	SPR CT, Chopper Pairs, SPR
LL 42	2N1995 2N1996 2N1997 2N1998 2N1999	TI TI TI TI TI	npn,ge npn,ge pnp,ge pnp,ge pnp,ge	1	150 150 250 250 250 250	85 85 100 100 100	2.5 2.5 3.3 3.3 3.3	15 15 15 15 15	300 300 500 500 500	*25 *35 *40 *70 *100	6 6 5 5 5	*20 *20 *20 *20 *20 *20	0.25 0.25 0.2 0.2 0.2	5 5 5 5	ETC ETC ETC

			That I			MA	X. RAT	INGS		(CHARACTI	ERISTICS			
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (MHz)	P _c (mW)	T _j (°C)	mW/°C	VCEO *VCBO (V)	C (mA)	hfe *hFE	lco *lceo (μΑ)	C _{oe} *C _{ob} (pF)	V _{ce(sat)}	Package Outline (TO-)	Remarks
	2N2000 2N2001 2N2188 2N2189 2N2190	TI TI TI TI	pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge	11111	300 300 125 125 125 125	100 100 85 85 85 85	4 4 2.1 2.1 2.1	15 15 25 25 25 25	1000 1000 30 30 30 30	*50 *100 40 60 40	10 6 3 3 3	*35 *35 *2.5 *2.5 *2.5	0.25 0.2 - - -	5 5 - -	
LL 43	2N2191 2N2551 2N2692 2N2871 2N2872	TI HU TI HU HU	pnp,ge pnp npn,si pnp pnp		125 400 300 400 400	85 160 175 160 160	2.1	25 150 30 60 110	30 - 50 - -	60 20 *90 20 20	3 0.01 - -	*2.5 - *5 -	- 0.2 - -	5 18 5 5	
	2N2938 3217 3218 3219 2N4058	RCA CT CT CT TI	npn,PE,si pnp,si pnp,si pnp,si pnp,PE,si		300 400 400 400 400 250	175 200 200 200 125	2.3 2.3 2.3 2.5	*25 *15 *25 *40 30	500 100 100 100 30	*60 10 5 3 100	.003 .001 .001 0.001 0.1	3.5 *14 *14 *14	0.22 - - - 0.7	18 45 46 46 92	SPR SPR SPR
LL 44	2N 4059 2N 4060 2N 4061 2N 4062 2013	TI TI TI TI BU	pnp,PE,si pnp,PE,si pnp,PE,si pnp,PE,si	1 - 1	250 250 250 250 250 500	125 125 125 125 125 150	2.5 2.5 2.5 2.5 2.5	30 30 30 30 *65	30 30 30 30 30 3.0	45 45 90 110 *30	0.1 0.1 0.1 0.1 0.5	- - - 7.0	0.7 0.7 0.7 0.7 0.7 0.5	92 92 92 92 92 †	† flat pack
	PADT60 SA-537 SA-538 SA-539 SA-540	AMP SPR SPR SPR SPR	pnpn,PADT,ge pnp,SP,si pnp,SP,si pnp,SP,si pnp,SP,si pnp,SP,si		83 150 150 150 150	75 140 140 140 140	1.7 1.3 1.3 1.3 1.3	*35 *25 *10 *25 *10	25 50 50 50 50	- 10 10 10 10	50 0.1 0.1 0.01 0.01	*5 *9 *9 *9	0.6 0.15 0.15 0.15 0.15	1 1 1 18 18	4 Layer Control Device
LL 45	V - 120RH V - 220 V - 221 V - 222	VEC VEC VEC VEC	npn,PL,si npn,PE,si npn,PE,si npn,PE,si	0.11	350 - - -	200 200 200 200 200		10 *15 *15 *15		*110 *70 *110 *140	.0001 5 5 5 5	*1.7 *3.0 *3.0 *3.0	.13 .30 .30 .30	18 18 18 18	



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AR16—AR24 replaces 363 JEDEC devices for 50 to 1000 V/.25 to 1A needs. Cost less than stud types.



SCR'S

MIL and industrial devices, including fast-switching types. Choice of ratings and package shapes.



Rectifier stacks, potted bridges, epoxy resin encapsulations and high voltage assemblies.



High-Level Switching

Generally types rated at one watt and above. In order of f_{α_e} or $f_{\rm T}$.

7.57						M	AX. RATIN	IGS		CHARA	CTERISTI	cs		
Cross Index Key	Type No.	Mfr.	Туре	fae *f _T (kHz)	P _c (W)	Т _ј (°С)	w/°c	*VCEO *VCBO (V)	I _C (A)	h _{fe}	ICO *ICEO †ICEX (mA)	V _{ce(sat)} (V)	Package Outline (TO-)	Remarks
HL 1	2N1518 2N1519 2N1520 2N1521 2N1522	DE DE DE DE DE	pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge pnp,AJ,ge	4 4 4 4 4	150 150 150 150 150	100 100 100 100 100	.5 .5 .5 .5	40 60 40 60 40	25 25 35 35 50	*15-60 *15-60 *17-68 *17-68 *25-100	4 4 4 4	.7 .7 .7 .7	36 36 36 36 36	ETC ETC ETC ETC ETC
	2N1523 2N2230 2N2231 2N2232 2N2233	DE WH WH WH	pnp,AJ,ge npn, AJ, si npn,AJ,si npn,AJ,si npn, AJ, si	4 7 7 7 7	150 150 150 150 150	100 150 150 150 150	.5 2 2 2 2 2	60 50 100 150 200	50 10 10 10 10	*25-100 *400 *400 *400 *400	4 10 10 10 10	.7 2.2 2.2 2.2 2.2 2.2	36 - - - -	ETC
HL 2	2N2560 2N2564 2N2565 2N618 2N1907	TI KSC KSC MO TI	pnp,ge pnp,ge pnp,ge pnp,AJ,ge pnp,ge	8 8 8 8.5 *10	20 20 20 90 60	100 100 100 100 100	0.5 0.5 0.5 1.25 2	*40 *40 *60 *80 *100	3 3 3 20	*20-60 *20-60 *20-60 *90 *20	0.65 0.65 0.65 0.8 0.5	- - .3 1,0	- - 3 3	NA, KSC, BE
W o	2N1908 2N2226 2N2227 2N2228 2N2229	TI WH WH WH WH	pnp,ge npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si	*10 10 10 10 10	60 150 150 150 150	100 150 150 150 150	2 2 2 2 2 2	*130 50 100 150 200	20 10 10 10 10	*20 *100 *100 *100 *100	0.5 10 10 10 10	1.0 2.2 2.2 2.2 2.2 2.2	3	
HL 3	2N1809 2N1810 2N1811 2N1812 2N1813	WH WH WH WH	npn, AJ, si npn, AJ, si npn. AJ, si npn, AJ, si npn, AJ, si	14 14 14 14 14	250 250 250 250 250 250	175 175 175 175 175 175	2.22 2.22 2.22 2.22 2.22 2.22	50 100 150 200 250	30 30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	0.4 0.4 0.4 0.4 0.4	-	
	2N1814 2N1830 2N1831 2N1832 2N1833	V/H WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	14 14 14 14 14	250 250 250 250 250 250	175 175 175 175 175 175	2.22 2.22 2.22 2.22 2.22 2.22	300 50 100 150 200	30 30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	0.4 0.875 0.875 0.875 0.875	-	
HL 4	2N2109 2N2110 2N2111 2N2112 2N2113	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	14 14 14 14 14	250 250 250 250 250 250	.75 175 175 175 175	2.22 2.22 2.22 2.22 2.22 2.22	50 100 150 200 250	30 30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	0.4 0.4 0.4 0.4 0.4		
	2N2114 2N2130 2N2131 2N2132 2N2133	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	14 14 14 14 14	250 250 250 250 250 250	175 175 175 175 175 175	2.22 2.22 2.22 2.22 2.22 2.22	300 50 100 150 200	30 30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	0.4 0.875 0.875 0.875 0.875		
HL 5	2N2739 2N2740 2N2741 2N2742 2N2757	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	14 14 14 14 14	200 200 200 200 200 200	175 175 175 175 175 175	2 2 2 2 2 2	50 100 150 200 50	20 20 20 20 20 30	*10 *10 *10 *10 *10	15 15 15 15 15	0.4 0.4 0.4 0.4 0.4		
	2N2758 2N2759 2N2760 2N2761 2N1816	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	14 14 14 14 14 14.5	200 200 200 200 200 250	175 175 175 175 175 175	2 2 2 2 2 2,22	100 150 200 250 50	30 30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	0.4 0.4 0.4 0.4 0.63		
HL 6	2N1817 2N1818 2N1819 2N2116 2N2117	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	14.5 14.5 14.5 14.5 14.5	250 250 250 250 250 250	175 175 175 175 175 175	2.22 2.22 2.22 2.22 2.22 2.22	100 150 200 50 100	30 30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	0.63 0.63 0.63 0.63 0.63	- - - -	
	2N2118 2N2119 2N2745 2N2746 2N2747	WH WH WH WH	npn,AJ,si npn,AJ,si npm,AJ,si npn,AJ,si npn,AJ,si	14.5 14.5 14.5 14.5 14.5	250 250 200 200 200 200	175 175 175 175 175 175	2.22 2.22 2 2 2	150 200 50 100 150	30 30 20 20 20	*10 *10 *10 *10 *10	15 15 15 15 15	0.63 0.63 0.63 0.63 0.63		
HL 7	2N2748 2N2763 2N2764 2N2765 2N2766	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	14.5 14.5 14.5 14.5 14.5	200 200 200 200 200 200	175 175 175 175 175 175	2 2 2 2 2 2	200 50 100 150 200	20 30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	0.63 0.63 0.63 0.63 0.63		

High-Level (continued)

						, A	AX. RATIN	IGS		CHAR	ACTERISTIC	CS		+ She will be
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (kHz)	P c (W)	T _j (°C)	w/°c	*VCEO *VCBO (V)	I _C	h _{fe} *hFE	ICO *ICEO †ICEX (mA)	V _{ce(sat)}	Package Outline (TO-)	Remarks
HL 8	2N1823 2N1824 2N1825 2N1826 2N2123	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	16 16 16 16 16	250 250 250 250 250 250	175 175 175 175 175 175	2.22 2.22 2.22 2.22 2.22 2.22	50 100 150 200 50	30 30 30 30 30 30	*10 *10 *10 *10 *10	15 15 15 15 15	0.74 0.74 0.74 0.74 0.74		
112 0	2N2124 2N2125 2N2126 2N2751 2N2752	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ.si npn,AJ,si	16 16 16 16 16	250 250 250 250 200 200	175 175 175 175 175 175	2.22 2.22 2.22 2.22 2 20	100 150 200 50 100	30 30 30 20 2	*10 *10 *10 *10 *10	15 15 15 15 15	0.74 0.74 0.74 0.74 0.74	-	
	2N2753 2N2754 2N2769 2N2770 2N2771	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	16 16 16 16 16	200 200 200 200 200 200	175 175 175 175 175	2 2 2 2 2 2	150 200 50 100 150	20 20 30 30 30	*10 *10 *10 *10 *10 *10	15 15 15 15 15	0.74 0.74 0.74 0.74 0.74	- - - -	
HL 9	2N2772 163-04 163-06 163-08 163-10	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	16 22 22 22 22 22	200 200 200 200 200 200	175 175 175 175 175	2 2 2 2 2 2	200 55 75 95 115	30 20 20 20 20 20	*10 *15 *15 *15 *15	1.5 15 15 15 15	0.74 .30 .30 .30	-	
	163-12 163-14 163-16 163-18 163-20	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	22 22 22 22 22 22	200 200 200 200 200 200	175 175 175 175 175 175	2 2 2 2 2 2	135 155 175 175 195 215	20 20 20 20 20 20	*15 *15 *15 *15 *15	15 15 15 15 15	.30 .30 .30 .30 .30	-	
HL 10	164-04 164-06 164-08 164-10 164-12	WH WH WH WH	npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si	22 22 22 22 22 22 22	200 200 200 200 200 200	175 175 175 175 175	2 2 2 2 2 2	55 75 95 115 135	20 20 20 20 20 20	*25 *25 *25 *25 *25 *25	15 15 15 15 15	.25 .25 .25 .25 .25	-	
	164-14 164-16 164-18 164-20 2N1015	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	22 22 22 22 22 22 25	200 200 200 200 200 150	175 175 175 175 175 150	2 2 2 2 2 1.43	155 175 195 215 30	20 20 20 20 20 7.5	*25 *25 *25 *25 *25 *10	15 15 15 15 15	.25 .25 .25 .25 .25	-	STC
HL 11	2N1015A 2N1015B 2N1015C 2N1015D 2N1015E	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	25 25 25 25 25 25	150 150 150 150 150	150 150 150 150 150	1.43 1.43 1.43 1.43 1.43	60 100 150 200 250	7.5 7.5 7.5 7.5 7.5 7.5	*10 *10 *10 *10 *10	10 10 10 10 10	0.5 0.5 0.5 0.5 0.5		STC STC STC STC STC
	2N1702 151-04 151-06 151-08 151-10	RCA WH WH WH	npn, si npn, AJ, si npn, AJ, si npn, AJ, si npn, AJ, si	25 25 25 25 25 25	75 100 100 100 100	200 150 150 150 150	0. 429 1.4 1.4 1.4 1.4	40 80 120 160 200	5 6.0 6.0 6.0 6.0	*15-60 *11 *11 *11 *11	0. 2 10 10 10 10	- 0.6 0.6 0.6 0.6	3	STC
HL 12	152-04 152-06 152-08 152-10 2N 1016	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	25 25 25 25 25 30	100 100 100 100 100 150	150 150 150 150 150	1.4 1.4 1.4 1.4 1.43	80 160 200 30	6.0 6.0 6.0 6.0 7.5	*18 *18 *18 *18 *18	10 10 10 10 10	0.9 0.9 0.9 0.9 0.9		STC
	2N1016A 2N1016B 2N1016C 2N1016D 2N1016E	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,FJ,si	30 30 30 30 30 30	150 150 150 150 150	150 150 150 150 150	1.43 1.43 1.43 1.43 1.43	60 100 150 200 250	7.5 7.5 7.5 7.5 7.5 7.5	*10 *10 *10 *10 *10	10 10 10 10 10	0.6 0.6 0.6 0.6 0.6	- - - -	STC STC STC STC STC
HL 13	2N1701	RCA	npn, si	30	25	200	.143	40	2.5	*20-80	.1	-	8	STC
	153-04 153-06	WH WH	npn,AJ,si npn,AJ,si	33 33	200 200	175 175	1,33 1,33	*65 *85	7.5 7.5	*15 *15	10 10	0.6 0.6	- -	
Ш. 11	153-08 153-10 153-12 153-14 153-16	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	33 33 33 33 33	200 200 200 200 200 200	175 175 175 175 175 175	1.33 1.33 1.33 1.33 1.33	*105 *125 *145 *165 *185	7.5 7.5 7.5 7.5 7.5 7.5	*15 *15 *15 *15 *15	10 10 10 10 10	0.6 0.6 0.6 0.6 0.6	-	
HL 14	153-18 153-20 154-04 154-06 154-08	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	33 33 33 33 33	200 200 200 200 200 200	175 175 175 175 175 175	1,33 1,33 1,33 1,33 1,33	*205 *225 *65 *85 *105	7.5 75 7.5 7.5 7.5	*15 *15 *25 *25 *25	10 10 10 10 10	0.6 0.6 0.9 0.9 0.9	-	

High-Level (continued)

L.						М	AX. RATIN	IGS	A	CHARA	CTERISTIC	S		
Cross Index Key	Type No.	Mfr.	Туре	f _{αe} *f _T (kHz)	P _c (W)	Т _ј (°С)	w/°c	V _{CEO} *V _{CBO} (V)	I _C	h _{fe} *hFE	ICO *ICEO †ICEX (mA)	V _{ce(sat)}	Package Outline (TO-)	Remarks
WI 15	154-10 154-12 154-14 154-16 154-18	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	33 33 33 33 33 33	200 200 200 200 200 250	175 175 175 175 175 175	1.33 1.33 1.33 1.33 1.33	*125 *145 *165 *185 *205	7.5 7.5 7.5 7.5 7.5 7.5	*25 *25 *25 *25 *25 *25	10 10 10 10 10	0.9 0.9 0.9 0.9 0.9	11111	
HL 15	154-24 2N1409 2N1410 2N1768 2N1769	WH RA RA	npn,AJ,si npn,si npn,si npn,si npn,si	33 *40 *40 40 40	200 2.8 2.8 40 40	175 150 150 200 200	1.33 .22 .22 .22 .229 .229	*225 *30 *30 40 55	7.5 05 0.5 3 3	*25 *30 *60 *35-100 *35-100	10 .010 .010 .015 .015	0.9 0.5 0.5 - -	5 5 -	GI GI STC STC
	2N3850 2N3852 2N2310 2N2311 2N2312	SSP SSP RA RA	npn,TDP npn,TDP npn,si npn,si npn,si	*40 *40 *50 *50 *50	30 30 3 3	200 200 300 300 300 300	0. 4 0. 4 .017 .017 .017	*100 *60 60 100 60	5 5 0.5 0.5 0.5	*150 *150 *12 *12 *12 *30	.0001 .0001 10 10	0.25 0.25 5 1.5	59 59 46 46 46	
HL 16	2N2313 2N2314 2N2315 2N2316 2N2317	RA RA RA RA	npn,si npn,si npn,si npn,si npn,si	*50 *50 *50 *50 *50	3 3 3 3 3 3	300 300 300 300 300 300	.017 .017 .017 0.17 0.17	100 35 35 60 40	0.5 0.5 0.5 0.5 0.5	*30 *15 *40 *40 *40	10 10 10 10 10	5 1.5 1.5 5 1.5	46 46 46 46 46	
	2N3506 2N3507 2N2270 2N3468 2N3495	MO MO RCA MO MO	npn, EA, si npn,EA, si npn, si pnp, EA, si pnp, EA, si	*60 *60 *100 *150 *150	5 5 5 5 3	200 200 200 200 200 200	0.029 0.029 .0286 0.0057 0.0172	40 50 45 50 120	3 3 1 1 100	*40-200 *30-150 *50-200 *25-75 *40	† 0. 001 † 0. 001 5 0.0001 0.0001	1.0 1.0 - 0.6 0.35	5 5 5 5	† Icex † Icex TRWS, GI
HL 17	2N3497 2N3498 2N3499 2N3500 2N3501	MO MO MO MO	pnp,EA,śi npn,EA,si npn,EA,si npn,EA,si npn,EA,si	*150 *150 *150 *150 *150	1.8 5 5 5 5	200 200 200 200 200 200	0.0103 0.0057 0.0057 0.0057 0.0057	120 100 100 150 150	100 0.5 0.50 0.30 0.300	*40 *40-120 *100-300 *40-120 *100-300	0.0001 0.00005 0.00005 0.00005 0.00005	0.35 0.4 0.4 0.4 0.4	18 5 5 5 5	TRWS
10 m	2N3634 2N3636 2N3253 2N3444 2N3467	MO MO MO MO	pnp,EA,si pnp,EA,si npn, AE, śi npn,AE,si pnp,EA,si	*150 *150 *175 *175 *175	5 5 5 5	200 200 200 200 200 200	0.029 0.029 0.029 0.029 0.029 0.0057	140 175 40 50 40	1 1 1 1	*50-150 *50-150 *25-75 *20-60 *40-120	0.00010 0.00010 0.0005 0.0005 0.0001	0.5 0.5 0.6 0.6 0.5	5 5 5 5 5	
HL 18	2N456B 2N457B 2N458B 2N1666 2N1667	TI TI TI AMP AMP	pnp,ge pnp, ge pnp,ge pnp,PADT,ge pnp,PADT,ge	*200 *200 200 200 200	150 150 150 30 30	100 100 100 90 90	2.0 2.0 2 -	30 40 45 60 48	7 7 7 6 6	*40 *40 *40 *55 140	0. 5 0.5 7.0 <100 <100	-	3 3 3 3 3	DE, KSC, ITT DE, KSC, ITT TI, DE
	2N 1668 2N 1669 2N 2397 2N 3252 2N 3426	AMP AMP SY MO FA	pnp,PADT,ge pnp,PADT,ge npn,PE,si npn,AE,si npn,PE,si	200 200 *200 *200 *200 *200	30 30 300 5 3.0	90 90 200 200 200	- - 0. 029 0. 017	48 60 *35 30 12	6 6 200 - 1.0	75 110 *25-120 *30-90 *50	<100 <100 0.1 0.0005 0.0000015	- 0.3 0.5 0.18	3 3 51 5	
HL 19	2N3429 2N3430 2N3431 2N3432 2N3433	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	*200 *200 *200 *200 *200	150 150 150 150 150	175 175 175 175 175 175	1.33 1.33 1.33 1.33 1.33	*50 *100 150 *200 *250	7.5 7.5 7.5 7.5 7.5	*10 *10 *10 *10 *10	10 10 10 10 10	0.9 0.9 0.9 0.9 0.9		
III 00	2N3434 2N3485 2N3485A 2N3486	WH MO MO MO	npn,AJ,sí pnp,AE,si pnp,AE.si pnp,AE,si	*200 *200 *200 *200	150 2 2 2 2	175 200 200 200	1.33 0.011 0.011 0.011	*300 40 60 40	7.5 0.6 0.6 0.6	*10 *40-120 *40-120 *100-300	10 0.00002 0.00001 0.00002	0.9 0.4 0.4 0.4	- 46 46 46	TI TI TI
HL 20	2N3486A 2N3494 2N3496 2N3635 2N3637	MO MO MO MO	pnp,AE,si pnp,EA,si pnp,EA,si pnp,EA,si pnp,EA,si	*200 *200 *200 *200 *200	2 3 1.8 5 5	200 200 200 200 200 200	0.011 0.0172 0.0103 0.029 0.029	60 80 80 140 175	0.6 100 100 1	*100-300 *40 *40 *100-300 *100-300	0.00001 0.0001 0.0001 0.00010 0.00010	0.4 0.3 0.3 0.5 0.5	46 5 18 5 5	TI
	2N2217	МО	npn,EA,si	250	3	175	. 02	30	0.8	20-160	0.00001	0.4	5	GI,SY,SPR,TR,AMP, TRWS,AL
	2N2218 2N2219	MO MO	npn,AE,si	*250 250	3	175 175	.02	30	0.8	*40 - 120 100-300	0.00001	- C. 4	5	GI, SY, SPR, TR, AMP, TRWS, AL GI, SY, SPR, TR, AMP
HL 21	2N2219 2N2219	MO	npn, AE, si npn, AE, si	250	3	175	.02	30	0.8	100-300	0.00001	0.4	5	GI, SY, SPR, TR, AMP,
	2N2220	MO	npn,AE,si	250	1.8	175	.012	30	0.8	20-60	0.00001	0.4	18	AL GI, SPR, TR, AMP,
	2N2221	МО	npn, AE, si	250	1.8	175	.012	30	0.8	40-120	0. 00001	0.4	18	AL GI, SPR, TR, AMP, AL

High-Level (continued)

						M	AX. RATIN	igs		CHARA	CTERISTIC	S		
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (kHz)	P _c (W)	T _j (°C)	w/°c	V _{CEO} *V _{CBO} (V)	I _C	h _{fe} *hFE	ICO *ICEO †ICEX (mA)	V _{ce(sat)}	Package Outline (TO-)	Remarks
	2N2222	МО	npn,AE,si	250	1.8	175	.012	30	0.8	100-300	0.00001	0.4	18	TRWS, GI, SPR, TR, AMP, AL
HL 22	2N3250A 2N3734 2N3504 2N3735	MO MO FA MP	pnp,AE,si npn,AE,si pnp,PE,si npn,AE,si	*250 *250 *250 *250	1.2 4 1.3 4	200 200 200 200	0.0069 .023 0.0022 .023	60 30 45 50	0.2 1.5 0.6 1.5	*50-150 *30-120 *70 *20-80	†0.00002 †.0002 0.050 †.0002	0.25 0.2 0.5 0.2	18 5 18 5	†Icex TI
1112 22	2N3736 2N3737 2N914/46 2N2481	MO MO SY MO	npn, AE,si npn,AE,si npn,PL,EP,si npn,AE,si	*250 *250 *300 *300	2 2 400 1.2	200 200 200 200	.011 .011 - 0.0069	30 50 *40 15	1.5 1.5 -	*30 - 120 *20 - 80 *30 - 120 *40 - 120	†.0002 †.0002 .025 0.00005	0.2 0.2 0.7 0.25	46 46 46 18	GI TI
	2N3251A 2N3647 2N3510 2N3714 2N3511	MO MO MO MO MO	pnp, AE, si pnp, EA, si npn, EA, si npn,si npn, EA, si	*300 *350 *350 *400 *450	1.2 2.0 1.2 150 1.2	200 200 200 200 200 200	0.0069 0.011 0.0069 .857 0.0069	60 10 10 80 15	0.2 0.50 0.50 10 0.50	*100-300 *25-150 *25-150 *25-90 *30-120	† 0. 00002 † 0. 000025 † 0. 000025 †1. 0 † 0. 000025	0.4	18 46 52 3 52	
HL 23	2N3648 2N3227 2N3055 2N3470 2N3471	MO MO RCA WH WH	npn, EA, si npn, AE, si npn, si npn, AJ, si npn, AJ, si	*450 *500 *500 *500 *500	2.0 1.2 115 150 150	200 200 200 150 150	0.011 0.0069 0.657 2 2	15 20 60 *50 *100	0.50 - 15 10 10	*30-120 *100-300 *20 - 70 *100 *100	†0.000025 0.0002 †5 10	0. 4 0.25 1.1 2.2 2.2	46 18 3 -	† Icev, MO
	2N3472 2N3473 2N3474 2N3475 2N3476	WH WH WH WH	npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si npn,AJ,si	*500 *500 *500 *500 *500	150 150 150 150 150	150 150 150 150 150	2 2 2 2 2 2	*150 *200 *50 *100 *150	10 10 10 10 10	*100 *100 *400 *400 *400	10 10 10 10 10	2.2 2.2 2.2 2.2 2.2 2.2		
HL 24	2N3477 2N3508 2N3509 2N3013 2N3014	WH MO MO FA FA	npn,AJ,si npn,EA,si npn,EA,si npn,PE,si npn,PE,si	*500 *500 *500 *550 *550	150 2.0 2.0 1.2 1.2	150 200 200 200 200 200	2 0.011 0.011 0.00685 0.00685	*200 20 20 15 20	10 - - - -	*400 *40-120 *100-300 *60 *60	10 0.0002 0.0002 40 40	2.2 0.25 0.25 0.16	- 46 46 52 52	TI TI
	2N3424 2N3546 2N3054 156-04 156-06	FA MO RCA WH WH	npn, PE, si pnp,EA,si npn, si npn,DJ,si npn,DJ,si	*600 *700 *1000 *1000 *1000	1.2 1.2 25 120 120	200 200 200 200 200 200	0.29 0.0069 0.143 0.68 0.68	15 12 55 40 60	.050 - 4 8 8	*20-200 *30-120 *25-100 *15 *15	0.000010 0.000010 1.0 20 20	0.4 0.15 1.0 1.0	- 18 66 3 3	
HL 25	156-08 156-10 0C80 0C22 0C23	WH WH AMP AMP AMP	npn,DJ,si npn,DJ,si pnp,PADT,ge pnp,PADT,ge pnp,PADT,ge	*1000 *1000 2000 2500 2500	120 120 .55 15 16	200 200 75 75 75	0.68 0.68 - .333 .333	80 100 *32 32 40	8 8 0.3 1	*15 *15 180 *200 *200	20 20 .01 .03 .03	1.0 1.0 - - -	3 3 1 3 3	
	0C24 2N551 2N552 2N1055 2N1212	AMP TR TR TR TR	pnp,PADT,ge npn,PL,si npn,PL,si npn,PL,si npn,PL,si	2500 3000 3000 3000 3000 3000	15 3 3 3 85	75 175 175 175 175	.333 .025 .025 .025 .025 .485	32 60 30 100 60	1 .2 .2 .2 .2 5	*200 *20-80 *20-80 *20-80 *12-36	.03 .015 .015 .015	- - 2 5	3 5 5 5	CDC, STC, SSP CDC, STC SSP STC, TI
HL 26	2N1620 2N545 2N546 2N547 2N548	TR TR TR TR TR	npn,PL,si npn,PL,si npn,PL,si pnp,PL,si npn,PL,si	3000 4000 4000 4000 4000	60 5 5 5 5	175 175 175 175 175	.40 .045 .045 .045 .045	*100 60 30 60 30	5 .8 .8 .8	*15-75 *15-80 *15-80 *20-80 *20-80	10 .015 .015 .015 .015		53 5 5 5 5	SSP, TI SSP, TI CDC, STC, SSP, TI CDC, STC, SSP, TI
	2N549 2N550 2N1117 2N3713 2N3715	TR TR TR MO MO	npn,PL,si npn,PL,si npn,PL,si npn,si npn,si	4000 4000 4000 *4000 *4000	5 5 5 150 150	175 175 175 200 200	.045 .045 .045 .857 .857	60 30 60 60 60	.8 .8 .8 10	*20-80 *20-80 *40-150 *25 - 90 *50 - 150	.015 .015 .015 †1.0 †1.0	- 4 1.0 1.0	5 - 5 3 3	CDC, STC, SSP, TI CDC, STC, TI STC, CDC, SSP, TI
HL 27	2N3716 2N3740 2N3741 2N1116 2N3738	MO MO MO TR MO	npn,si pnp,si pnp,si npn,PL,si npn,si	*4000 *4000 *4000 6000 *15,000	150 25 25 5 20	200 200 200 175 175	.857 .143 .143 .045 .133	80 60 80 60 225	10 1 1 .8 .250	*50 - 150 *30 - 100 *30 - 100 *40-150 *40 - 200	†1.0 0.1 0.1 .015 0.1	1.0 0.6 0.6 5 2.5	3 66 66 5 66	STC, CDC, SSP, TI
	2N3739 2N3766 2N3767 2N1983 2N1984	MO MO MO FA FA	npn,si npn,si npn,si npn,DD,si npn,DD,si	*15,000 *15,000 *15,000 *30000 *30000	20 20 20 20 2	175 175 175 175 150 150	.133 .133 .133 0.016 0.016	300 60 80 25 25	.250 1 1 - -	*40 - 200 *40 - 160 *40 - 160 100 80	0.1 0.1 0.1 0.001 0.001	2. 5 2. 5 2. 5 0. 25 0. 25	66 66 66 5	TRWS, CDC, AMP. AL
HL 28	2N1985 2N698	FA FA	npn,DP,si npn,DP,si	*30000 *40000	2 3	150 200	0.016 0.0172	25 60		60 *40	0.001	0.25	5 5	TRWS, CDC, AMP, AL TRWS, TR, GI,
	2N2852 2N2856	SSP SSP	npn,PE,si npn,PE,si	*40000 *40000	5 5	200 200	0.005 0.005	*100 *60	5 5	*45 45	0.001 0.001	0.2	5 5	AMP, CDC TI TI

(see pages 4-9 for explanation of company abbreviations.)

May 17, 1966 89

High-Level (continued)

						1	MAX. RATIN	GS		CHAR	ACTERISTI	CS		
Cross Index Key	Type No.	Mfr.	Туре	fae *f _T (kHz)	P _c (W)	T _j (°C)	₩/°C	VCE0 *VCB0 (V)	I _C (A)	h _{fe} *hFE	ICO *ICEO †ICEX (mA)	V _{ce(sat)} (V)	Package Outline (TO-)	Remarks
	2N1899 2N1901 2N1902 2N1904 2N1978	TRWS TRWS TRWS TRWS	npn,PL,si npn,PL,si npn,PL,si npn,PL,si npn,DP,si	*50000 *50000 *50000 *50000 *50000	125 125 125 125 125 30	150 150 150 150 200	1 1 1 1 0.172	*140 *140 *140 *140 *60	10 10 10 10 10	*10-30 *20-60 *10-30 *20-60 *30	10 10 10 10 0.001	1.0 1.0 1.0 1.0 1.0		
HL 29	2N1986 2N1987 2N1988	FA FA	npn,DD,si npn,DD,si npn,DD,si	*50000 *50000 *50000	2 2 .	150 150 //	0.016 0.016 0.016	25 25 45	-	150 50 *75	0.001 0.001 0.001	0.4 0.4 1.5	5 5 5	TRWS, CDC, GI AMP, AL TRWS, CDC, GI, AMP, AL TRWS, CDC, GI, AL
	2N 1989 2N 1991 2N 3076	FA FA TRWS	npn,DD,si pnp,DD,si npn,PL,si npn,DD,si	*50000 *50000 *50000	2 2 125 1.5	150 150 150	0.016 0.016 1	45 *30 *140 *60	- - 10	*40 *30 *30-90 *40	0.001 0.001 25	1.5 1.2 1.0	5 5 *	TRWS, CDC, GI, AL TRWS, KSC, TR, MO Single Ended *MT-38 Case TRWS, CDC, TR, GI
HL 30	2N719 2N719A 2N720A	FA FA	npn,DD,si npn,DP,si npn,DP,si	*60000 *60000	1.5 1.8 1.8	175 200 200	0.010 0.0103 0.0103	*120 *120 *120	-	*40 *40 *80	0.001 .000005	2.5 0.8 0.9	18 18	AMP, NA TRWS, CDC, TR, GI TRWS, CDC, AMP, AL, GI, TR TRWS, CDC, GI,
	2N721 2N909 2N912 2N978 2N2850	FA FA FA SSP	pnp, DD, si npn, DD, si npn, DP, si pnp, DD, si npn, PE, si	*60000 *60000 *60000 *60000 *60000	1.5 1.5 1.8 1.25 5	175 175 200 150 200	0.010 0.010 0.0103 0.010 0.005	35 *60 60 20 *100	- - - - 5	*60 *250 45 *30 *85	0.001 .00001 .000005 .001	1.0 0.3 0.16 1.3 0.15	18 18 18 18 5	AMP, AL, NA, TR, RCA KSC, TR TRWS, AMP TRWS, AMP, AL TR
HL 31	2N2851 2N2853 2N2855 2N1972 2N1975	SSP SSP SSP FA FA	npn,PE,si npn,PE,si npn,PE,si npn,DD,si npn,DP,si	*60000 *60000 *60000 *60000 *60000	5 5 5 2 3	200 200 200 175 200	0.005 0.005 0.005 0.010 0.0172	*100 *60 60 *60 60	5 5 5 -	*85 *85 85 *250 45	0,001 0.001 .0001 .00005	0.2 1.0 0.2 0.4 0.16	5 5 5 5	AMP, TR, TRWS TRWS, CDC, AMP.
III 00	2N3117 2N3719 2N3720 2N3879 2N911	FA MO MO RCA FA	npn,DP,si pnp,AE,si pnp,AE,si npn,si npn,DP,si	*60000 *60,000 *60,000 *60,000 *70000	1.2 6 6 35 1.8	200 200 200 200 200 200	0.00685 .034 .034 0.2 0.0103	60 40 60 75 60	- 3 3 10(peak)	*300 *25 - 180 *25 - 180 *20 - 80 70	.00001 .01 .01 *5 .00005	0.3 0.75 0.75 1.2 0.13	18 5 5 66 18	UC TRWS, AMP, AL
HL 32	2N1131 2N1974 2N696 2N699	FA FA FA	pnp,CD,si npn,DP,si npn,DD,si npn,DD,si	*70000 *70000 *80000 *80000	2 3 2 2	175 200 175	0.0133 0.0172 0.0133 0.0133	35 60 *60 *120	600 - - -	*30 70 *40 *80	0.001 .000005 .00001	1.0 0.13 -	5 5 5	KSC. TR. MO TRWS, CDC, AMP TRWS, TR, GI, AMP CDC, NA TRWS, SY, TR, CDC AMP, NA, RCA
	2N718 2N718A	FA FA	npn ,DD,si npn,DP,si	*80000 *80000	1.5	175 200	0.010 0.0103	*60 *75	-	*75 *80	.000003	0.7	18	TRWS, CDC, SY, TR GI, AMP, AL, NA, MO CDC, MO, TR, GI, AMP, AL, NA, RCA, MO, TRWS
HL 33	2N720 2N870 2N910 2N1252	FA FA FA	npn,DD,si npn,DP,si npn,DP,si npn,DD,si	*80000 *80000 *80000 *80000	1.5 1.8 1.8 2	175 200 200 175	0.010 0.0103 0.0103 0.0133	*120 60 60 *30	1 1 1	*80 *75 140 *35	.001 .00004 .00005 .0001	2.5 0.6 -0.13 0.6	18 18 18 5	TRWS, CDC, TR, GI AMP, AL, NA GI, AMP, AL TRWS, AMP, AL SY, AL, NA
	2N1613 2N1973 2N2849 2N2854	FA FA SSP SSP	npn,DP,si npn,DP,si npn,PE,si npn,PE,si	*80000 *80000 *80000 *80000	3 5 5	200 200 200 200 200	0.0172 0.00456 0.005 0.005	*75 60 *100 *60	- - 5 5	*80 140 *150 *150	.00003 .0005 - 0.001	0.6 0.13 0.2 0.2	5 5 5 5	TRWS, CDC; MO. TR. AMP, RCA TRWS, CDC, AMP,
HL 34	2N3919 2N3920 2N3108 2N3110 2N722	FA FA FA FA	npn,DPE,si npn,DPE,si npn,DP,si npn,DP,si pnp,DD,si	80000 80000 *86000 *86000 *90000	15 15 5 5 1.5	150 150 200 200 275	.200 .200 0.0286 0.0286 0.010	60 60 60 40 35	2 2 - - .00001	*40 *100 *70 *70 *50	- .0004 .0004 .Q01	.6 .6 0.16 0.16 1.0	3 3 5 5 18	KSC, MO, TR
HL 35	2N1132 2N1838 2N1839 2N1840 2N871	FA TRWS TRWS TRWS FA	pnp, DD, si npn, PL, si npn, PL, si npn, PL, si npn, DP, si	*90000 *90000 *90000 *90000 *100000	2 2 2 2 2 1.8	175 175 175 175 175 200	0.0133 .013 .013 .013 0.0103	35 *45 *45 *25 60	0.6 0.50 0.50 0.50 -	*45 *40-150 *12-50 *10-100 *130	.00001 .0015 .0015 0.30 .0004	1.0 1.4 1.4 1.4 0.35	5 5 5 18	KSC, TR, MO CDC CDC CDC CDC CDC, GI, AMP, AL
AL 33	2N1420 2N1711	FA FA	npn,DD,si npn,DP,si	*100000 *100000	3	175 200	0.0133 0.0172	*60 *75	-	*200 *130	.00001	0.7 0.5	5	TRWS, CDC, MO, TR GI, NA, AMP TRWS, CDC, MO, AMP, GI, AL, TR, NA RCA

High-Level (continued)

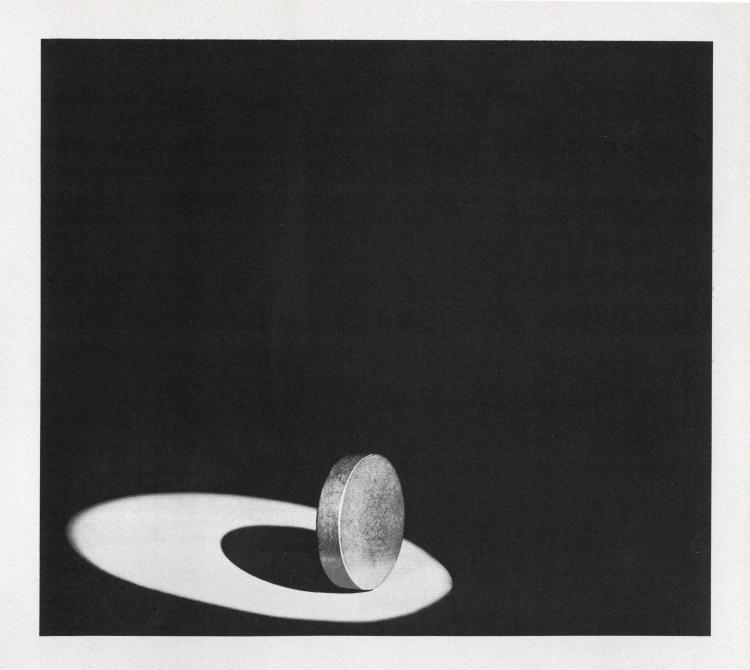
						М	AX. RATIN	IGS		CHARA	CTERISTIC	:S		
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (kHz)	P _c (₩)	Т _ј (°С)	w/°c	VCEO *VCBO (V)	I _C (A)	h _{fe} *hFE	ICO *ICEO †ICEX (mA)	V _{ce(sat)} (V)	Package Outline (TO-)	Remarks
	2N1893A 2N3053 2N1253 2N219A	TRWS RCA FA GE	npn,PL,si npn,si npn,DD,si npn,PE,si	*100000 *100,000 *110000 *130000	3 5 2 2.8	200 200 175 200	.017 0.0286 0.0133 .016	80 40 *30 40	0.50 0.7 - 1	*40-120 *50-250 *45 *100-300	.0001 0.00025 .0001	2.0 1.4 0.6 .25	5 5 5 5	GI, TR, NA AL, NA GI, NA, CDC, FA, MO, AL
HL 36	2N2193A 2N2194A	GE GE	npn,PE,si npn,PE,si	*130000 *130000	2.8 2.8	200 200	.016 .016	50 40	1 1	*40-120 *20-60	10	.25	5 5	CDC, GI, NA, MO, AL CDC, GL NA. FA MO, AL
	2N2195A 2N2243A	GE GE	npn,PE,si npn,PE,si	*130000 *130000	2.8 2.8	200 200	.016 0.16	25 80	1	*20 *40-120	10	.25	5 5	CDC, GI, MO, AL GI, NA
	- 2N2350A 2N2351A 2N2352A 2N2353A 2N2364A	GE GE GE GE	npn,PE,si npn,PE,si npn,PE,si npn,PE,si npn,PE,si	*130000 *130000 *130000 *130000 *130000	5 5 5 5	200 200 200 200 200 200	.0285 .0285 .0285 .0285 .0285	25 50 40 25 80	1 1 1 1 1	*20 *40-120 *20-60 *20 *40-125	1 1 1 1	25 25 .25 .25 25 .25	46 46 46 46 46	NA NA NA NA, CDC
HL 37	2N1837 2N3763 2N3765 2N3762 2N3764	TRWS MO MO MO MO	npn,PL,si pnp,AE,si pnp,AE,si pnp,AE,si pnp,AE,si	*140000 *150,000 *150,000 *180,000 *180,000	2 4 2 4 2	175 200 200 200 200 200	.013 .023 .011 .023 .011	*80 60 60 40 40	0.50 1.5 1.5 1.5 1.5	*40-120 *20 - 80 *20 - 80 *30 - 120 *30 - 120	.0005 †.0001 †.0001 †.0001 †.0001	0.8 0.1 0.1 0.1 0.1	5 5 46 5 46	CDC
III .00	BF140 BF155 2N947 2N3502 2N3503	NUC NUC FA FA FA	npn,si npn,si npn,DP,si pnp, PE,si pnp, PE,si	*180 MHz 180 MHz *250000 *250,000 *250,000	1 1 1.2 3.0 3.0	- 200 200 200 200	- 0.0069 0.017 0.017	*135 *155 *20 60 60	- 0.1 .600 0.6	*40 *40 *40 *70 *70	0.001 0.001 .0001 0.05 0.0000000	- 0.3 0.5 0.5	5 5 18 5 5	TI TI
HL 38	2N3505 2N915	FA FA	pnp, PE, si npn, DP, si	*250,000 *300000	1.3 1.2	200 200	0.0023 0.0069	45 50	0.6	*70 *100	0.0000000 .0005	0.5	18 18	TI TRWS, AMP, NA, MO, AL
	BSY18 BSY63	SA SA	npn,EP,PL,si npn,EP,PL,si	*300,000 *300,000	1.0 1.0	200 200	0.007 0.007	12 *40	0.2	*40120 30120	0.000025 0.000025	0.25 0.4	18 18	AL
	2N3512 2N708	RCA FA	npn, EP, si npn, DP, si	375,000 *400000	4 1.2	200 200	0.0069	*60 15	-	80 *50	0.5 .0004	0.28 0.3	5 18	SY, TR, GI, AMP RCA, MO, FA, NA
	2N916 2N3299	FA FA	npn, DP, si npn, PE, si	*400000 *400,000	1.2 3.0	200 200	0.0069 0.017	25 *30	-	*100 *75	.0005 0,0000002	0.4	18 5	TRWS, AMP, NA, MO
HL 39	2N3300 2N3301 2N3302 BSY34 BSY58	FA FA FA SA SA	npn, PE, si npn, PE, si npn, PE, si npn, EP, PL, si npn, EP, PL, si	*400,000 *400,000 *400,000 *400,000	3. 0 1. 8 1. 8 2.6 2. 6	200 200 200 200 200 200	0.017 0.010 0.010 0.016 0.016	*30 *30 *30 40 25	- - 0.6 0.6	*220 *75 *220 42 *42	0.0000002 0.0002 0.0002 0.00001 0.00012	0.4 0.4 0.4 0.3 0.3	5 18 18 5 5	
	2N2368 2N3209 2N2455 2N3423 2N2369	FA FA SY FA FA	npn,PE,si npn,PE,si npn,EP,ge npn,PE,si npn,PE,si	*550000 *550000 600,000 *600,000 *650000	1.2 1.2 150 1.2 1.2	200 200 100 200 200 200	0.0685 0.00685 - 0.29 0.00685	15 20 *15 15 15	0.5 0.0002 200 .050 0.5	*40 *75 *20-100 *20-200 *80	.0001 .00002 2.0 0.000010 .0001	0.2 0.07 .19 0.4 0.2	18 18 18 - 18	TR, AL, SPR AL, NUC, SPR
HL 40	2N3303 2N917 2N418 2N420 2N420A	FA FA BE BE BE	npn,PE,si npn,DP,si pnp,ge pnp,ge pnp,ge	*650000 *800000 - - -	3.0 0.3 25 25 25 25	200 200 100 100 100	0.017 0.00171 0.5 0.5 0.5	12 15 - -	1.0 - 5 5 5	*60 50 *40 *40 *40	0.1 .00005 1.0	0.18 0.4 - - -	- 18 3 3 3	MO AL, TI, RCA, TRWS KSC, ITT ITT ITT
UI A1	2N424A 2N637 2N637A 2N637B 2N638	STC BE BE BE BE	npn pnp,ge pnp,ge pnp,ge		85 25 25 25 25	200 100 100 100 100	.483 0.5 0.5 0.5 -	80 *25 *60 *60	3 5 5 5	*12-60 *30-60 30-60 *30-60	- 0.5 2-5 2-5 -	- .8-1.5 .5 .5	53 3 3 3	STC, TR, BE KSC KSC KSC KSC
HL 41	2N638A 2N638B 2N656 2N657	BE BE TI TI	- npn,si npn,si	1115	- 4 4	- 200 200	- 0.0228 0.0228	- 60 100	1 - 1 - 1	- *30 *30	- 0.010 0.010	1111		KSC KSC TRWS, FA, TR, AMP, TRWS, FA, TR, AMP, CDC, STC, SSP
WI 40	2N730 2N731 2N1011 2N1038 2N1039	TI TI BE TI TI	npn,si npn,si pnn,ge pnp,ge pnp,ge		0.5 0.5 35 20 20	175 175 95 100 100	3.33 3.33 0.5 0.267 0.267	*60 *60 *80 *40 *60	1 1 5 3 3	*20 *40 *35-75 *20 *20	1 1 5 0.125 0.125	1.5 1.5 1.5 0.25 0.25	18 18 3 -	TR TR MO, ITT SY SY
HL 42	2N1040 2N1041 2N1046 2N1046A 2N1046B	TI TI TI TI	pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge		20 20 30 50 50	100 100 100 100 100	0.267 0.267 0.400 1.0 1.0	*80 *100 50 50 50	3 3 12 12 12	*20 *20 *40 *40 *40	0.125 0.125 2.0 2.0 2.0	0.25 0.25 0.4 0.4 0.9	3 3 3 3	SY

(see pages 4-9 for explanation of company abbreviations.)

May 17, 1966 91

High-Level (continued)

						MA	X. RATIN	IGS		CHARA	CTERISTI	CS		27.7
Cross Index Key	Type No.	Mfr.	Туре	fae *fT (kHz)	P _c (W)	Т _ј (°С)	w/°c	V _{CEO} *V _{CBO} (V)	I _C	h _{fe} *hFE	ICO *ICEO †ICEX (mA)	V _{ce(sat)}	Package Outline (TO-)	Remarks
	2N1073 2N1073A 2N1073B 2N1208 2N1209	BE BE BE TR TR	pnp,ge pnp,ge pnp,ge npn,PL,si npn,PL,si	- - - -	60 60 60 85 85	110 110 110 175 175	0.833 0.833 0.833 .485 .485	*25 *60 *100 60 45	10 10 10 5 5	*20-60 *20-60 *20-60 *15 *20-80	15 20 20 10 20	1 1 1 5 5	41 41 41 -	DE, MO DE, MO DE, MO STC, TI STC, TI
HL 43	2N1238 2N1239 2N1240 2N1241 2N1242	HU HU HU HU	pn p pnp pnp pnp pnp		1 1 1 1	160 160 160 160 160		15 15 35 35 60	-	20 40 20 40 20			-	
	2N1243 2N1244 2N1990	HU HU FA	pnp pnp npn,DD,si	-	1 1 2	160 160 150	- 0.016	60 110 *100	- - 1	40 20 *30	- - 0.001	- 0.4	- - 5	TRWS, CDC, GI, AMP, AL, NUC
	2N2285	BE	pnp,ge	1233	100	110	1.25	30	25	*35-140	5	-	3	AWIF, AL, NOC
HL 44	2N2286 2N2287 2N2288 2N2289 2N2290	BE BE BE BE BE	pnp,ge pnp,ge pnp,ge pnp,ge pnp,ge	- - - -	100 100 60 60 60	110 110 110 110 110	1.25 1.25 0.833 0.833 0.833	60 80 *40 *80 *120	25 25 10 10 10	*35-140 *35-140 *20-60 *20-60 *20-60	5 5 5 5 5	- - - -	3 3 3 3 3	
	2N2291 2N2292 2N2293 2N2294 2N2295	BE BE BE BE BE	pnp,ge pnp,ge npn,ge pnp,ge pnp,ge		60 60 60 60	110 110 110 110 110	0.833 0.833 0.833 0.833 0.833	30 50 70 30 50	10 10 10 10 10	50-200 50-200 50-200 50-200 50-200	5 5 5 1 1	-	3 3 3 41 41	
HL 45	2N2296 2N2359 2N2358 2N2357 2N2389	BE BE BE TI	pnp,ge pnp,ge pnp,ge pnp,ge npn,si		60 170 170 170 170 0.45	110 110 110 110 200	0.833 2 2 2 2 0.00257	70 30 60 80 *75	10 50 50 50 50	50-200 *30-90 *30-90 30-90 35	2 50 50 50 10	- - - 1.5	41 41 41 - 50	
	2N2390 2N2394 2N2395 2N2410 2N2411	TI TI TI TI	npn,si pnp,si npn,si npn,si pnp,si		0.45 0.45 0.45 0.8 0.3	200 175 200 200 200	0.00257 0.003 0.00257 0.00457 0.00172	*75 35 40 30 20	0.5 0.3 0.3 0.8 0.1	*100 30 *20 *30 *20	10 1 10 0.3 10	1.5 1.5 1.0 0.45 0.2	50 50 50 50 5	SY, NA
HL 46	2N2526 2N2527 2N2528 DTG1110	MO MO MO DE	pnp,AD,ge pnp,AD,ge pnp,AD,ge pnp,PADT,ge	- - -	85 85 85 80	110 110 110 110	1.25 1.25 1.25 1.0	80 120 160 *200	10 10 10 15	2050 20-50 20-50	3 3 3 -	0.8 0.8 0.8 0.5	3 3 3 3	DE



CRYSTAL SUPPORTS: FRONT AND CENTER

When you stop to realize that the crystal support is a required part of any semi-conductor, you'll realize that it's more than coincidence that the leading semi-conductor manufacturers specify Stackpole crystal supports rather than manufacturing their own.

You see, they know that a compatible coefficient of thermal expansion just isn't enough. They also need Stackpole's unique combination of good electrical conductivity,

excellent thermal conductivity, and a surface finish which assures wetability. And they depend on the flat surfaces which Stackpole features to give them maximum contact and conductivity between the base and crystal.

Get on this bandwagon...let Stackpole supply your guest conductors, too. Phone, wire or write Stackpole Carbon Company, Carbon Division, St. Marys, Pa.



How, why and where to use FETs can be determined by referring to their parameters. Here's a detailed look at the meaning of these characteristics and how to apply them.

What's so special about field-effects? How alike are the junction-FET and the metal-oxide semiconductor (MOS)? Where are they to be preferred over bipolar transistors? Which of their parameters indicate their suitability for specific

applications?

In response to these questions, we have prepared a detailed examination which shows how to choose between different units in the FET family. It also offers guide lines for making the most effective use of field-effect devices in circuit design. It takes a long look at FET specifications, shows how and why they are measured and where each one is of prime importance. And finally, it explains the meaning of each parameter.

This parameter-oriented analysis of field-effects

clarifies:

- What's unique about them and how they work;
- How to interpret and use the parameter specifications;
- Which parameters govern their small-signal behavior; and
- The difference in characteristics and applications of junction-FETs and MOSs.

The basic properties of FETs

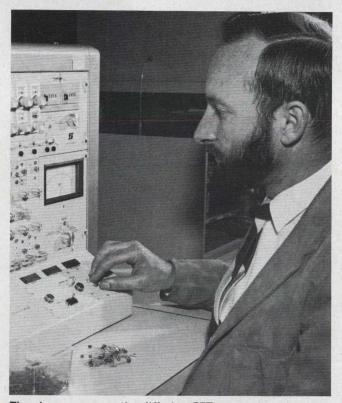
The field-effect transistor (FET) has a number of important attributes that set it apart from other active semiconductor devices: extremely high input resistance, nearly constant current-output characteristics, an almost completely unilateral gain function, a controllable temperature coefficient, and voltage-controlled resistance when operated at low drain-source voltages.

Many users think of the highly popular FET as a near-universal replacement for the vacuum tube. And indeed, its qualities are such that it does possess the dc characteristics of the pentode vacuum tube (Fig. 1a). Present limitations, however, generally restrict FET use to circuits operating below 500 MHz and at power levels less than a few hundred milliwatts.

The FET is simplicity itself, consisting only of a conducting channel flanked by a pair of control electrodes (Fig. 1b). Source and drain connections are made to either end of the channel, and a gate connection is made to the control electrodes. The primary gate electrode may be a pn junction (junction-FET) or an insulated metal electrode (MOS-FET). The secondary gate electrode is a pn junction in any case. A voltage applied between gate and source (or gate and drain) modulates the cross-sectional area of the channel, thus controlling channel resistance.^{1,2}

Very high power gain is a FET feature

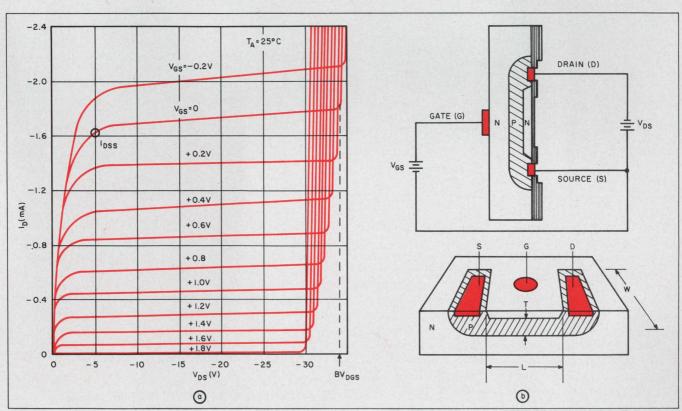
The input resistance is that of a reverse-biased silicon pn junction (SiO_2 insulated-metal electrode in MOS devices), and is measured in gigaohms ($>10^{12}$ ohms for MOS) at dc. The FET is a voltage- or field-controlled device exhibiting very high power gain at low frequencies. Because neither load nor signal current crosses the gate-channel junction, there is almost perfect input-output isolation and unilateral gain.



The closer you pare the differing FET properties, the more apparent becomes their suitability for various applications. Author Sherwin measures FET parameters on a MONITOR automatic FET/transistor test set.

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Parameter	Test condi- tions (must be specified)	Mean of specification	Parameter	Test condi- tions (must be specified)	Meaning of specification
BV_{GSS}	$\begin{matrix} I_{\rm G} \\ V_{\rm DS} \!=\! 0 \end{matrix}$	Breakdown voltage from gate to channel. Drain and source are shorted, and a reverse bias is placed across the gate-channel junction. This is shown as the breakdown point where $V_{\rm GS} \approx BV_{\rm GSS}$. (Fig. 3)	lgss	$\begin{matrix} V_{\rm GS} \\ V_{\rm DS} \! = \! 0 \end{matrix}$	Gate-channel leakage with $V_{\rm DS}=0$. This represents total gate leakage current at a point below breakdown voltage (Fig. 3) Specified at $\frac{1}{2}$ to 1 times the minimum specified BV _{GSS} . When specified at min BV _{GSS} , I _{GSS} may replace the BV _{GSS} specifica-
$BV_{\mathtt{GDS}}$	$V_{DS} = 0$	Identical to BV _{GSS} .			tion in that loss is < lo in the BV _{GSS} specification.
BV _{GDO}	$l_{\rm s} = 0$	Breakdown voltage from gate to drain with source open. Under these conditions V _{GS} \approx V _{GS(OFF)} due to self-biasing required to prevent current flow from drain to source.	Iрдо	V_{DG} $I_{S} = 0$	Drain-to-gate leakage current with source open. As $V_{GS} \approx V_{GS(OFF)}$ for reasons indicated under BV_{DG} , $I_{GS} \neq 0$. Then $-I_{DGO} = I_{GD}$ [at specified V_{DG}] + I_{GS} [at $V_{GS} \approx V_{GS(OFF)}$].
BVsgo	$l_{\scriptscriptstyle D}=0$	Breakdown voltage from gate to source with drain open. $V_{\text{GD}} \approx V_{\text{GD}(\text{OFF})}$.			See Fig. 4 for a comparison of IGSS, IDGO, ISGO, and IDGOFF. IDGO is representative of IG un-
BV _{DSS} BV _{DGS}	$V_{\rm GS} = 0$	Breakdown from drain to source with $V_{\rm GS}{=}0$. This is normally specified for Type-C MOS devices. It represents			der worst probable operating conditions when $V_{\rm GS} = V_{\rm GS(OFF)}$ and $V_{\rm DG} = {\rm maximum}$ allowable.
		breakdown from drain to substrate.	Isgo	$V_{\rm sg}$ $I_{\rm D}=0$	Source-to-gate leakage current with drain open. Note
BV _{DSX}	V_{GS}	Breakdown from drain to source with $V_{\rm GS} \neq 0$. Nor-			that $-I_{\text{SGO}} = I_{\text{GS}}$ at $[V_{\text{DG}}] + I_{\text{GD}}$ at $[V_{\text{GD}} \approx V_{\text{GD(OFF)}}]$.
		mally specified only for Type-B MOS devices when $V_{\rm GS} > V_{\rm GS(OFF)}$. It represents breakdown from drain to substrate.	lo	V_{DS} or V_{DG} V_{GS}	Gate leakage current under certain operating conditions. In is usually somewhat lower than logo since logo is the limiting case of In.



 $1.\ \mbox{FET}$ output characteristics resemble those of the pentode (a). Construction (b) shows how voltage applied

between the gate and source terminals modulates channel resistance.

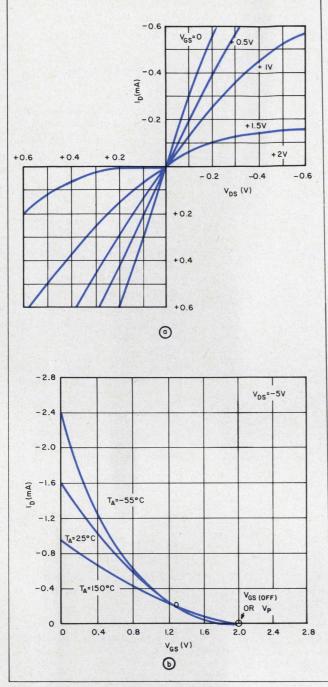
Parameter	Test conditions (must be specified)	Meaning of specification	Parameter	Test condi- tions (must be specified)	Meaning of specification
IDSS	$V_{D8} V_{G8} = 0$	Drain saturation current, the value of I _D measured above the knee of the V _{DS} ·I _D charac-	V _{P1} , V _{G1S} (OFF)	$\begin{array}{l} V_{\rm DS} \\ I_{\rm D} \\ V_{\rm G2S} = 0 \end{array}$	Gate 1 cut-off voltage for tetrodes.
		teristic curve, where $V_{\rm DS} > V_{\rm P}$ (Fig. 1). $I_{\rm DSS}$ is actually defined as $I_{\rm D}$ at the $V_{\rm DS}$ required for channel pinch-off	V _{P2} , V _{G2S} (OFF)	$\begin{array}{l} V_{\rm DS} \\ I_{\rm D} \\ V_{\rm G1S} = 0 \end{array}$	Gate 2 cut-off voltage for tetrodes.
		when the two gate-channel-junction depletion regions meet near the drain. 6 V $_{68}$ must be zero. At this point $_{1D}$ is self-limiting, and any	V _{GS} (th)	V _{DS}	Gate-threshold voltage. Gate- source voltage required to initiate channel conduction in Type-C MOS devices (Fig. 5b).
		increase in V _{DS} causes only slight increase in I _D . ⁷ In Type-C MOS devices, I _{DSS} is essentially the drain-substrate leakage plus any residual drain-source channel current.	V _{GS} (r-t)	$\begin{array}{l} V_{\rm DS} \\ I_{\rm G} \\ V_{\rm G2S} = 0 \end{array}$	Gate-to-gate reach-through voltage. Found in tetrodes only. This is the point at which gate current flows from gate to gate. Measured with $V_{\rm G2S} = 0$, hence the subscript GS(r-t) rather than
D(ON)	V _{DS} V _{GS}	Drain current under specified bias conditions. Specified for Type-B and Type-C MOS devices as a max intended op-	V _{GS}	V _{DS}	G1G2(r-t). Gate-source voltage at any given operating point.
		vas is biased for max channel conduction.	V _{GS} x	V _{DS} or V _{DG}	Same as $V_{\rm GS}$ but a particular set of operating conditions is implied.
l _D	V _{DS} or V _{DG} V _{GS}	Drain-source current under certain specified operating conditions.	V _{GSZ}	V _{DS} or V _{DG}	Same as $V_{\rm GSX}$ but often used to denote $V_{\rm GS}$ for zero temperature coefficient operation.
ldx	V _{DS} Or V _{DG} V _{GS}	Same as I _D but a particular set of operating conditions is implied.	$\left V_{\rm GS1}\text{-}V_{\rm GS2}\right $	V _{DG} Is or I _D	Magnitude of gate-to-gate dif- ferential offset voltage in dif-
DZ	V_{DS} or V_{DG}	Same as I _{DX} but often used to denote drain current for zero temperature-coefficient operation.	$\triangle \left V_{\rm SG1}\text{-}V_{\rm GS2} \right $	V _{DG} Is or I _D	ferential (matched) pairs. Change in $ V_{\rm GS_1}\!\!-\!V_{\rm GS_2} $ over given temperature range.
ID(OFF)	V _{DS} V _{GS}	Drain-gate leakage current with $V_{\rm GS}$ $>$ $V_{\rm GS(OFF)}$. This	$\frac{\triangle V_{GS1}\text{-}V_{GS2} }{\triangle T}$	T _{A1} & T _{A2}	Incremental change in $ V_{\rm GS1}-V_{\rm GS2} $ expressed in $\mu V/{}^{\circ} C.$
		represents the drain current observed in an analog-gate circuit which has been biased to the OFF state. ID(OFF)		$V_{\rm DS}$ $V_{\rm GS} = 0$	Match in $I_{\rm DSS}$ of differential pairs, expressed as a fraction.
V _{GS} (OFF)	V_{DS}	is slightly lower than logo (Fig. 7a). Gate cut-off voltage. Gate-		V _{DS} & V _{GS} V _{DG} or & I _D T _A	Magnitude of match in l ₀ for differential pairs. Usually specified at an elevated tem-
V GS (OFF)	l _D	source voltage required to cut-off channel current (Fig. 5b).	rds (on)	l _D	perature near 100°C. Static drain-source resist-
V _P		Pinch-off voltage, inter- changeable with V _{GS (OFF)} .		V _{DS} &/or V _{GS}	ance when biased to full ON condition (maximum operating I_D).

The output resistance is that of a current-limited device when operating with drain-gate voltages of more than a few volts, as shown by the flat section of the output-characteristic curves in Fig. 1a. Magnitude of output conductance ranges from 1 to 100 μ mhos, depending on device geometry. When operating at very low values of drain-source voltage, the FET behaves as a voltage-controlled resistor. The output-characteristic curves drawn in Fig. 2a for a low value of applied V_{DS} retain the same slope crossing through the origin. Thus, r_{ds} exhibits a bidirectional characteristic for low V_{DS} values of either polarity.

The temperature dependence of drain current is the combined effect of a negative temperature coefficient due to the majority carrier mobility and a positive temperature coefficient due to the change in gate-channel depletion-layer potential. (As the depletion region narrows with increasing temperature, thus increasing the channel cross-section, a positive temperature coefficient of drain current results). The two temperature-dependent effects tend to cancel and, at a specific value of I_D or V_{GS} , a zero temperature coefficient exists. The effect is shown on the transfer curves of Fig. 2b.^{4,5}

Breaking the specification dilemma

Despite wide use of field-effect units, a number of their parameter specifications are still not



2. A voltage-controlled-resistance property exists in FETs; it is bidirectional and is limited to the low-level region of $V_{\it DS}$ (a). A zero temperature coefficient, exhibited by most FETs, can be seen on the transfer curve (point 0 on b).

clearly understood. FET data sheet specifications may also seem confusing to some who have worked only with bipolar transistors. Since a proper grasp of the parameters is essential, those likely to be encountered will be explained. Table 1 contains both the definitions and the necessary test conditions.

Some of the parameters are self-explanatory; others become clearer if a schematic or characteristic curve is provided (see Figs. 3-6. Note that leakage effects are included.^{6,7}). The small-signal characteristics of FETs and MOSs involve admittance, transconductance, capacitance and resistance terms (Table 2). FET operation here is

typified by biasing so that the largest ac signal to be amplified is small in comparison to the dc bias current and voltage. Equally interesting are the response times and equivalent-noise parameters, the most important of which are presented in Table 3.

The distinction between FET and MOS

The MOS or insulated-gate FET differs from the junction-FET in that the primary gate of the MOS is a metal electrode electrically isolated from the channel by an oxide.⁸ This gives it its name, metal-oxide-semiconductor (MOS) or insulated-gate field-effect transistor (IGFET). The generalized structure of the MOS is shown in Fig. 7.

A p-type substrate is used for an n-channel MOS. Into the substrate are diffused two separate N+ regions: these become the source and drain connections. Next, an oxide layer is grown over the entire surface. Holes are then etched through the oxide layer over the N+ regions. Finally, a metal pattern is deposited on the surface allowing metal contact through to the source and drain connections. The metal region over the oxide spanning the two N+ regions is the gate electrode. There is no conducting channel from source to drain.

This process produces a normally-OFF or enhancement-mode MOS, which will not conduct until a positive control signal is applied to the gate. Fig. 8 shows the effect of a positive gate potential applied with respect to the channel. Owing to the electrostatic field created, a redistribution of the minority carriers in the p-type substrate occurs.

This results in the formation of an n-type resistive channel between source and drain. As the gate potential is increased, the channel carrier concentration and induced-channel depth increase to form a lower resistance channel. Thus, the electric field at the gate creates and controls the resistance of a conducting channel between source and drain. This device is now being described on data sheets as a Type-C Field-Effect Transistor, an enhancement-type device, according to EIA JEDEC type registration procedures. It may be conveniently described as a normally-OFF device.

A second type of MOS is the normally-ON or depletion-mode MOS (Fig. 9). This is similar to the device in Fig. 7 except that a conducting channel exists from source to drain in the absence of a gate voltage. A negative gate voltage depletes the channel of carriers, and a positive gate voltage enhances the channel or increases the number of carriers. This device may therefore operate in either the depletion or enhancement mode. Data sheets refer to this device as a Type-B, a depletion unit intended for both enhancement-mode and depletion-mode operation.

The junction field-effect transistor (JFET or just plain FET) is referred to as Type-A, a depletion-type device only for depletion-mode operation. Operation of the three devices is made appar-

Table 2. Small Signal Characteristics of FETS

Parameter	Test Conditions (must be specified)	Meaning of specification	Parameter	Test Conditions (must be specified)	Meaning of specification
rds (on)	V _{GS}	Drain-to-source resistance	gis		Same as giss.
y _{fs}	V _{DS} = 0 or Is frequency	when biased to full ON condition (max operating I _D). Magnitude of common-source	goss		Common-source output con ductance with input shorted
		forward transfer admittance. Sometimes the magnitude signs are omitted. Measured at $V_{\rm GS}=0$, unless otherwise specified.	RE y _{oss}	V _{DS} & V _{GS}	Real part of y_{oss} . Identically equal to g_{oss} . Sometimes used instead of g_{oss} .
gts		Magnitude of common-source forward transfer conductance. Sometimes the magnitude signs are omitted. This	Im y _{oss}	v _{gs} =0 frequency	Imaginary part of y_{oss} . Out put susceptance b_{oss} . Identically equal to $1/\omega C_{oss}$. Some times used in lieu of C_{oss} .
		is perhaps a more informative term than y_{rs} . At 1kHz, $y_{rs} \approx g_{rs}$. However, at high	Ciss	V _{DS} V _{GS}	Common-source input capacitance, output shorted. $C_{1s} = C_{dg} + C_{gs}$. (Fig. 6).
		frequencies y_{ts} includes the effect of gate-drain capacity,	Cis	v _{ds} =0 frequency	Same as Ciss if Vds=0.
		hence may be misleadingly	Cgss		Same as C _{1ss} . Reverse transfer capaci
		high. The term g _{rs} should be used for all high-frequen- cy measurements.	Crss	V_{DS} V_{GS}	tance, input shorted.
_	V 9 V		Crs	$v_{gs} = 0$	Same as Crss.
g _{fsx}	V _{DS} & V _{GS} or V _{DG} & I _D	Same as g _{rs} but a particular set of operating conditions is implied.	Cdg	frequency	Same as Crss, actual value of drain-gate capacitance.
g _{fs1}	frequency	Match in grs for differential	Cgs	Values in	Actual value of gate-capacitance.
gfs2		pairs. Expressed as a fraction.	Cds	equivalent circuit not	Actual value of drain-source
gfsx1 gfsx2		Match in g _{fsx} for differential pairs.		measurable directly.	capacitance, essentially header capacitance.
grsz		Same as g_{rsx} but often used to denote g_{rs} when biased for zero temperature coefficient operation.	Coss	V _{DS} V _{GS}	Common-source output ca pacitance, input shorted. $C_{\rm os} = C_{\rm rss} + C_{\rm ds}$. However, $C_{\rm ds}$ is essentially header capaci
g _m		Mutual conductance. Sometimes used in lieu of grs.	Cos	v _{gs} =0 frequency	tance. Same as C_{oss} if $v_{gs} = 0$.
g _{mo}		Same as gm, but specifically	$C_{ m dgs}$		Same as Coss.
y tss		at V _{GS} =0. Common-source input admittance with output shorted. Important for high-frequency operation.	C_{sgs}	$\begin{array}{c} V_{\rm DS} \\ V_{\rm GS} \\ v_{\rm dg} \! = \! 0 \\ \text{frequency} \end{array}$	Source-to-gate capacitance gate and drain shorted. $C_{\rm sg} = C_{\rm gs} + C_{\rm ds}$.
giss	$\begin{array}{c} V_{\rm DS} \\ V_{\rm GS} \\ v_{\rm ds} \! = \! 0 \\ \text{frequency} \end{array}$	Common-source input conductance with output shorted. This must be specified for high-frequency applications as $g_{1ss} \propto 1/\omega^2$.	Cdgo	V_{DG} V_{GS} or $I_{\mathrm{S}} = 0$ $i_{\mathrm{s}} = 0$ frequency	D rain-to-gate capacitance with source open. $C_{\rm dgo} = C_{\rm rs}$ $+ \frac{C_{\rm gs} \; C_{\rm ds}}{C_{\rm gs} + C_{\rm ds}} > C_{\rm rss}$, cut $< C_{\rm dgs}$
Re yiss	nequency	Real part of y_{iss} . Identically equal to g_{iss} . Sometimes used instead of g_{iss} .	$C_{ m sgo}$	$\begin{array}{c} V_{\rm GS} \\ V_{\rm DS} \text{ or } I_{\rm D} {=} 0 \\ i_{\rm d} {=} 0 \\ \text{frequency} \end{array}$	$\begin{array}{l} \text{Source-to-g at e capacitance} \\ \text{with drain open.} C_{\rm sgo} \!=\! C_{\rm g} \\ + \frac{C_{\rm dg} \; C_{\rm ds}}{C_{\rm dg} \!+\! C_{\rm ds}} \end{array} > \!\! C_{\rm gs} \text{, but } < \!\! C_{\rm sgs} \end{array}$

ent by the Type-A, -B, and -C gate-to-drain transfer characteristics (see Fig. 5b).

Gate control separates MOS from FET

Construction differences between the MOS and FET result in some fairly significant differences in electrical characteristics, including bidirectional gate control, gate current, breakdown paths, dc stability and noise. Bidirectional gate control, already described, is graphed in Fig. 5b.

While FET gate input resistance decreases sharply when forward-biased more than a few tenths of a volt, the MOS gate may be biased to either polarity. As a result, MOS drain current is limited by dissipation and breakdown characteristics rather than by input-resistance considerations. The ON resistance of the depletion-type MOS may then be considerably decreased below that of the zero-bias state. Characterization of the MOS will include $r_{ds(on)}$ in an enhanced state at a given V_{gs} , where $I_{D(ON)}$ is also specified.

The Type-C enhancement-mode MOS is unique in the FET family because it is normally in an OFF state. I_{DSS} is a very low value, similar to $I_{D(OFF)}$ of Types A and B. A new term for Type-C devices only, gate-source threshold voltage $V_{GS(th)}$, describes the gate voltage at which drain current

Table 3. FET Performance Parameters

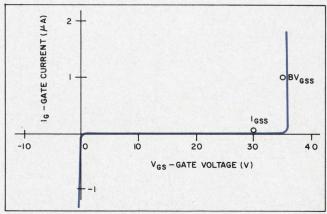
	Test condi-	
	tions (must	
Parameter	be specified)	Mean of specification
tdelay(on)	V _{DD} I _{D(ON)} V _{GS(ON)}	Delay time before turn or when pulsed from OFF to ON condition.
trall	V _{GS(OFF)} Test circuit Pulse rate	Fall time when pulsed from OFF to ON condition.
tdelay(off)	Input pulse characteristics	Delay time before turn of when pulsed from ON to OFF condition.
trise	Oscilloscope character-istics	Rise time when pulsed from ON to OFF condition.
ton	.5000	trall+tdelay(on).
tott		trise+tdelay(off).
en	V _{DS} · V _{GS} or I _D frequency bandwidth	Common-source equivalent short-circuit input noise voltage. Measured at the output with the input shorted, and referred to the input. Expressed as rms volts per root cycle, $\mu V/\sqrt{Hz}$. A function of frequency, so frequency value must be stated
Ī _n	V _{DS} V _{GS} or I _D frequency bandwidth	Common-source equivalent open-circuit input noise cur rent. Expressed as pA/\sqrt{Hz} a function of frequency.
NF	V _{DS} V _{GS} or I _D R _{generator} frequency bandwidth	Noise figure. This represents a ratio between input signal to noise and output signal to noise. NF is a function both of frequency and of genera tor resistance R _s . Both must be stated or the specification is meaningless. When properly qualified, NF includes the effects of both e _n and i _n

begins to increase. Except for a translation along the V_{gs} axis, $V_{gs(th)}$ is not unlike $V_{gs(off)}$ in Types A and B. In fact, the difference between Type-B and Type-C devices is a simple translation of the transfer curve along the V_{gs} axis (see Fig. 5a).

Gate current of the MOS is predictably much less than that of the FET because of the insulating properties of the oxide layer. MOS and FET gate currents may be compared in much the same manner as the leakage of a ceramic dielectric capacitor may be compared to the reverse current of a signal diode. Whereas FET gate current exhibits a significant temperature and voltage dependence, the dc input resistance of the MOS gate is generally greater than 10¹² ohms under all operating conditions.

A better understanding of breakdown

The voltage breakdown characteristics of the MOS differ markedly from those of the FET. The FET exhibits an avalanche breakdown across the most highly stressed point (draingate) of the gate-channel diode junction. In tetrode devices (junction FETs with two gates), there is also a reach-through breakdown from gate to gate when the channel becomes depleted of majority carriers at gate bias levels approaching the cut-off



3. FET input gate characteristic shows the breakdown point where $V_{\it GS} \approx BV_{\it GSS}$ (see Table 1).

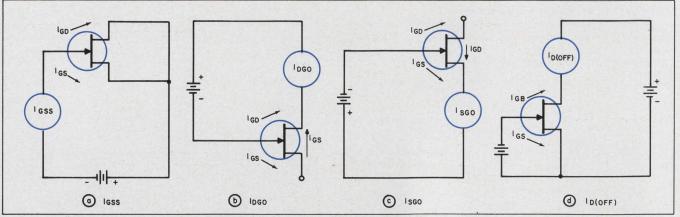
Table 4. FET and MOS applications

Application	Preferred MOS	device FET
Analog switch	X	X
Digital switch	х	
General-purpose amplifier		X
Low-noise amplifier		X
High-frequency amplifier	X	X
Differential amplifier		X
Low-drift single-ended amplifier		х

voltage. Different values of reach-through voltage are observed on gates 1 and 2, which are of unequal resistivity. It is important to note that in tetrodes, where one gate (usually the substrate gate) has been internally connected to the source, it is impossible to measure I_{gss} or BV_{gss} at voltage levels above the gate-1 reach-through value.

The MOS breakdown mechanisms are of a different nature. Take, for example, the enhancement of device. Breakdown from gate-to-source or gate-to-drain depends upon the thickness and quality of the insulating oxide. When the dielectric strength of the oxide is exceeded, breakdown occurs, puncturing the insulating layer. The breakdown is destructive in nature because a virtual short circuit occurs at the puncture point. This type of breakdown is quite common in dry climates when adequate handling precautions are not observed. For instance, a static electric potential of several thousand volts may easily build up on the gate from contact with nylon smocks. The gate then becomes permanently damaged. To avoid this, some manufacturers supply units with built-in Zener protection or with shorting clips across the gate-to-source junction.

There is also a breakdown from source to drain



4. Leakage currents that flow in the FET are measured with these circuits (see Table 1).

on the Type-C and Type-B units when either is biased to cut-off. In each case there is no channel connecting the source and drain which are isolated by the substrate. If the substrate is floating, two diodes appear back-to-back between source and drain. Drain-to-source breakdown (BV_{DSS}) occurs in either polarity across one or the other of these diodes.

If a Type-B device is under consideration, BV_{DSS} is usually replaced by BV_{DSX} where the subscript X indicates some specific bias condition— $V_{GS} > V_{GS(OFF)}$ in this case. When the substrate is internally connected to the source, the breakdown takes place across the drain-substrate junction. A drain-source voltage greater than a few tenths of a volt of opposite polarity will cause forward conduction of the drain-substrate junction. This condition prevents use of the device in high-level, analog-switching circuits.

FET more stable than MOS

The dc stability of the MOS is inferior to that of the FET. Whereas, with the FET, the equivalent drift of V_{GS} is a predictable and repeatable function of temperature, that of the MOS is dependent upon temperature and/or V_{GS} history (recent past excursions). When a gate-channel voltage is applied to the MOS, there is a charge migration in the insulating oxide. When the bias is removed, the time required for restoration of equilibrium is a function of the bias applied, the length of time the bias had been applied, and the temperature both during biasing and after removal of bias.

As these relationships are complex, it is impossible to predict residual gate field conditions accurately. The effect of the disturbance in charge equilibrium is that a residual gate bias exists; this controls the channel as if a small but unknown gate voltage were present. The effect on drain current is that of an indeterminate translation of the gate-drain transfer-characteristic curve horizontally along the $V_{\rm GS}$ axis. High-voltage bias alone has some effect, but high-temperature storage by itself has no effect except to speed the return to equilibrium. The variation in drain current from normal may be less than one per cent

after a period of low-voltage biasing at room temperature. It may rise to 30% after several hours of 10-volt biasing at 100°C.

A specific bias point exists on FETs where the drain current exhibits a zero temperature coefficient. Such a point also exists for the MOS, except that a true zero temperature coefficient is rarely, if ever, observed. In MOSs, a zero t.c. exists only for a much smaller range of temperature variation. Bias stability has been observed to be no better than $\Delta |V_{GS}| = 0 - \approx 10$ mV for a variation of 75°C. This compares with $\Delta |V_{GS}| < 0.5$ mV over $\Delta T = 100$ °C for the FET.

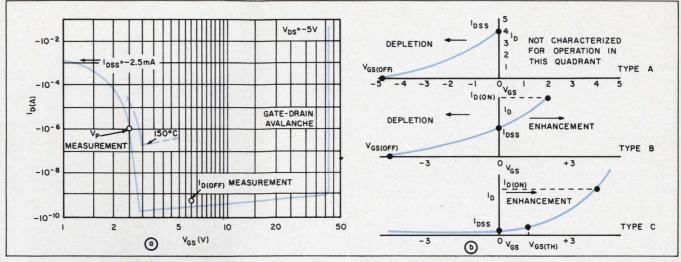
The noise performance of the MOS is also inferior to that of the FET, except perhaps at VHF and above.¹⁰ A high level of excess noise is present at low frequencies, and is believed to be due to the relatively unprotected nature of the MOS channel surface.

MOS forte is switching applications

From the preceding discussion of electrical characteristics, it is apparent that the MOS is well suited for some, but not all, circuit applications. Table 4 serves as a guide to suitable FET and MOS applications. A listing in the table does not necessarily mean that the unlisted device is not suitable for the application, but that the listed device is preferred.

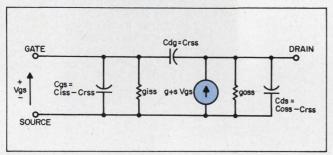
Several manufacturers have developed multiple MOS arrays in digital integrated circuits. They have been acclaimed as a means of reducing size, cost and power consumption of digital computers. The MOS is very well suited to switching applications because, as the control voltage varies to turn the device ON, a voltage clamp is not required to prevent gate current flow.

Considerable use of the MOS as an analog multiplexer gate may occur within the next few years. The capabilities of $I_{D(OFF)}$ less than 1 nA, $r_{ds(on)}$ less than 100 Ω , and the normally-OFF advantage are all-important in this application. It is necessary in these analog gating circuits for the MOS substrate to be isolated from source and drain so that the V_{DS} may be of either polarity. Consider the analog gate circuit of Fig. 10a which uses a connected-substrate MOS. Note that if a

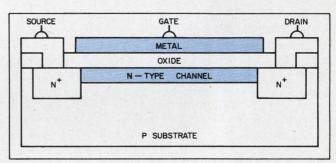


5. Transfer characteristic (a) shows how key parameters V_P and $I_{D(OFF)}$ are measured (see Table 1). This is for a Type-A FET unit (depletion mode). All three FET types

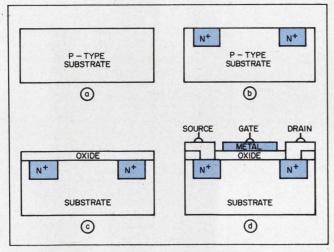
(depletion, depletion-enhancement (Type-B) and enhancement (Type-C) have unique transfer properties (b). Each governs device suitability for different applications.



6. The equivalent circuit of the FET is used in small-signal applications (see Table 2).



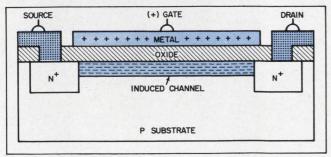
9. **Depletion-type MOS** is a normally-ON device. With zero gate potential, conducting channel from source to drain.



7. Starting with a p-type substrate (a), three additional steps are used in MOS construction.

negative input signal were present, the drainsubstrate junction would become forward-biased, allowing signals to appear at the output even in the absence of a gate drive. In the circuit of Fig. 10b, an MOS with isolated-substrate is used. Here the substrate is biased more negative than the largest signal to be handled, thus preventing drain-substrate conduction.

Another point of consideration in analog gate circuit design is the relationship between threshold voltage and signal voltage. With the gate at ground potential, a negative signal on the source is equivalent to a positive V_{GS} . Then, if the MOS in Fig. 10b is in its normally-OFF state, the $V_{GS(th)}$ must exceed the maximum peak-signal level.



8. An enhancement channel is formed in the MOS when a positive gate potential is applied.

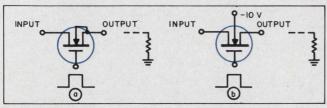
Low ON resistance a high point

In digital switching applications, the MOS is the most promising device available. The desirable characteristics for this are low ON resistance, low capacitance, high switching speed, high input resistance, high threshold voltage, and a normally-OFF state. The Type-C MOS may be designed to meet all of these characteristics within reasonable limits. Low ON resistance increases switching speed and produces low $V_{DS(ON)}$ values.

The latter term is equivalent except in magnitude to $V_{CE(sat)}$ of bipolar transistors. Low

101

May 17, 1966



10. The MOS is well suited for analog-switching. A connected-substrate unit is an analog gate (a) for basic multiplexing. The isolated-substrate version blocks output signals (b) when the input goes negative.

capacitance provides for increased switching speed. High input resistance yields a high fan-out capability. High threshold voltage produces good noise immunity. The normally-OFF state allows for simple direct-coupled operation with a single power supply. Combinations of normally-ON and normally-OFF MOS devices within a digital system are another intriguing possibility.

The MOS is not specifically suitable as a general-purpose amplifier because of the drain current instability with bias and temperature. In applications where ambient temperature is moderate and some drift in operating point is tolerable, the normally-ON MOS may be useful. Audio-frequency applications would be limited to medium and/ or high-level signals, owing to the large amount of excess noise exhibited by present MOS devices at low frequencies. Because of its relatively inferior noise performance, the MOS is ill-suited as a low-frequency, low-noise amplifier.

MOS is O.K. for RF amplification

The MOS is also limited for use in dc amplifier circuits because of the instability problem already noted. The only possibility at present for this application would be when the MOS is biased near the zero temperature coefficient point. This use is limited only to dc amplifiers with moderate short-term drift performance requirements and a wide latitude on long-term drift performance. The instability restricts the MOS to laboratory uses allowing > 10-m V drift in V_{GS} and military applications allowing >100-mV drift.

The MOS does, however, show promise for use as an RF amplifier, particularly where the squarelaw transfer characteristic produces very low levels of cross-modulation. The low input conductance of the MOS makes it suitable for efficient operation to several hundred megahertz. And, although low-frequency noise is excessive, highfrequency noise may be of a sufficiently low magnitude to permit uhf operation with noise figures below 5 dB.

FET applications are not exclusively limited to amplifiers. FETs are ideally suited to switching applications where the load resistance is high compared to channel resistance. The most important characteristics for each application are listed in Table 5. When referring to the FET tables (pp. 104 to 112), consult these key parameters. They are indices of the suitability of a device for a

Table 5. FET applications

Application		Characteristic Definition
Analog switch	rds(on) D(OFF) Cdgs/Csgs	Series ON resistance OFF leakage current
	$\frac{or}{C_{dgo}/C_{sgo}}$	Gate-channel capacitance
Digital	rds (on)	ON resistance
switch	V _{GS(th)}	Control voltage threshold
	V _{GS(OFF)} t _(on) +t _(off)	Sum of rise, fall, and switch ing delay times
General- purpose	loss	Drain current at zero gate bias
amplifier	grs V _{GS} (OFF)	Transconductance at zero gate bias Gate cut-off voltage
Low-noise amplifier	e _n	Equivalent short-circuit input noise voltage
	Īn	Equivalent open-circuit input noise current
	NF grs	Noise figure for a given source resistance Transconductance
High-fre- quency amplifier	grs Crss	Transconductance Reverse transfer capacitance, drain-to-gate
	g _{iss}	Input conductance at intended operating frequency Input capacitance
Differential amplifier	$\frac{\triangle V_{GS1} - V_{GS2} }{\triangle T} \\ V_{GS1} - V_{GS2} \\ I_{G1} - I_{G2} $	Differential input voltage drift with temperature Initial input offset voltage at 25°C
	gfsx gfss/gfs2	Input current match at maximum operating temperature Transconductance under operating conditions Transconductance match under operating conditions
Low-drift	loz	Zero temperature coefficient drain current
single- ended amplifier	g _{fsz} I _G V _{GSZ}	Transconductance at lbz Gate current at lbz Gate-source voltage at lbz

particular application.*

*A more detailed treatment of FET and MOS applications will be provided in a three-part follow-up design article appearing in the next 3 issues of Electronic Design.

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2. John D. Tomkins, "FET Terminology and Parameters," EDN, July, 1964, p. 48.

3. C. D. Todd, "FETs As Voltage Variable Resistors,"

ELECTRONIC DESIGN, Sept. 13, 1965, p. 66.
4. L. J. Sevin, "Effect of Temperature on FET Characteristics," Electro-Technology, April, 1964, p. 103.
5. L. L. Evans, "Biasing FETs for Zero DC Drift," Electro-Technology, Aug., 1964, p. 93.
6. W. Shockley, "A Unipolar Field-Effect Transistor,"

6. W. Shockley, "A Unipolar Field-Effect Transistor," Proc. IRE, Nov., 1952, p. 1365.
7. Grosvaldt et al., "Physical Phenomenon Responsible

for Saturation Current in Field-Effect Devices," Solid State Electronics, Jan.-Feb., 1963, p. 65.

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9. Mitchell and Ditrick, "Stability Effects in MOS Enhancement Transistors," Solid State Design, Nov., 1965,

10. Jordan and Jordan, "Theory of Noise in MOS Devices," IEEE Transactions on Electron Devices, ED-XII

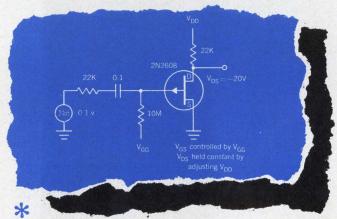
No. 3 (March, 1965), 142.

LESS DISTORTION WITH FETs

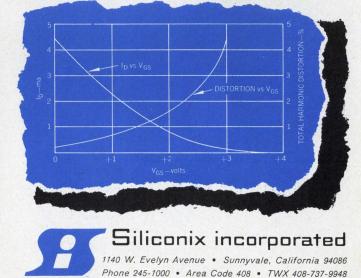
the best performance from DC to 500 MHz

Cross-modulation distortion in FM, TV, and communications receiver r-f stages is minimized by using devices with square-law transfer characteristics. A tube's power-law characteristic produces much less cross-modulation than the bipolar transistor with its exponential characteristic. The best answer of all is the FET, with its perfect square-law characteristic. Next time you're working on an r-f design, plug in one of the Siliconix 2N3821-24 series and measure the remarkable improvement.

Harmonic distortion in low-frequency amplifiers comes from (A) a nonlinear transfer characteristic and (B) input impedance variations with signal level, resulting in nonlinear loading on the signal source. The latter problem is the major cause of distortion in bipolar transistor amplifiers lacking a constant-current drive. With the high input impedance FET the problem is eliminated. The curve shows that amplitude distortion increases as the FET's bias point is moved toward cutoff. The square-law transfer characteristic explains this effect.



The whole distortion story is much longer, so we'd like to mail it to you. Circle the number on the card and you'll receive the undistorted viewpoint on low-distortion FETs.



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Field-Effect

Type 1(a). Analog-switching: Listed by descending order of $r_{\rm ds(on)}$.

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	rds(on) [Max.] (ohms)	I _{D(off)} [Max.] (µA)	Cdgs *Csgs or †Ciss [Max.] (pF)	BVGSS or *BVDSS [Min.] (volts)	VGS (off) or *VGS(TH) [Max.] (volts)	9fs [MinMax.] (µmhos)	IGSS or *IDGO [max.] (nA)	IDSS [MinMax., (mA)	ТО-	Alternate Sources and Remarks
FET 1	K1504 2N3610 2N3376 2N3377 C6692	KMC GME SI SI CT	p,M,4 p,M,4 p,DP,F,3 p,DP,F,3 n,EP,F,3	10000 3000 1500 1500 1500	10 - 0004 0004 1.0	4.5 0.6 3 2 5	25 *-20 30 30 25	-8 *-7 5 5 6	800 150 (min) 800-2300 800-2300	0.05 0.0002 3 3 1.0	.05 0.00001 -(0.6-6.0) -(0.6-6.0)	18 18 72 - 18	Flat pack
	2N2497 2N3329 2N3460 D1185 D1303	TI TI AL DIC DIC	p,DP,F,3 p,DP,F,3 n,DPE,F,3 n,DPE,F,3 n,DPE,F,3	1000 1000 1000 1000 1000	0.01	- 6 6 6	- 50 40 25	15 5 2 2 2	1000-2000 1000-2000 1000-4500 1000-4500 1000-4500	10 10 - -	1-3 1-3 0.2-1 0.2-1 0.2-1	5 72 18 18 18	UC UC DIC, SI, UC
FET 2	DNX9 TIXS11 2N2498 2N3330 2N3378	DIC TI TI TI SI	n,DPE,F,3 p,PL,M,3 p,DP,F,3 p,DP,F,3 p,DP,F,3	1000 1 00 0 800 800 750	- 0.01 0.01 - 0004	6 3	50 30 - - 30	2 *3-6 15 6 5	1000-4500 800 (min) 1500-3000 1500-3000 1500-2300	- 0.003 10 10 3	0.2-1 - 2-6 2-6 -(3-6)	18 72 5 72 72	SI, UC
EET 0	2N3379 2N3437 2N3459 C6690 C6691	SI DIC DIC CT CT	p,DP,F,3 n,DPE,F,3 n,DPE,F,3 n,EP,F,3 n,EP,F,3	750 700 700 700 700 700	0004 - 1.0 1.0	2 6 6 5 5	30 50 50 30 25	5 4 4 10 10	1500-2300 1500-6000 1500-6000	3 - - 1.0 1.0	-(3-6) 0.8-4 0.8-4 -	- 18 18 18 18	Flat pack
FET 3	D1184 D1302 DNX8 2N2499 2N3331	DIC DIC DIC TI TI	n,DPE,F,3 n,DPE,F,3 n,DPE,F,3 p,DP,F,3 p,DP,F,3	700 700 700 600 600	11111	6 6	40 25 50 -	4 4 4 15 8	1500-6000 1500-6000 1500-6000 2000-4000 2000-4000	- - 10 10	0.8-4 0.8-4 0.8-4 0.5-15 5-15	18 18 18 5 72	
	2N3380 2N3381 2N3631 2N3436 2N3458	SI SI SI DIC DIC	p,DP,F,3 p,DP,F,3 n,M,3 n,DPE,F,3 n,DPE,F,3	600 600 550 450 450	0005 0005 0001 -	3 2 1.6 6	30 30 20 50 50	9.5 9.5 -6 8	1500-2300 1500-2300 1400-2800 2500-10,000 2500-10,000	3 3 - 0.25	-(3-20) -(3-20) 2-10 3-15 3-15	72 - 18 18 18	Flat pack
FET 4	D1183 D1301 DNX7 M100 2N3382	DIC DIC DIC SI SI	n, DPE, F, 3 n, DPE, F, 3 n, DPE, F, 3 n, M, 3 p, DP, F, 3	450 450 450 350(typ) 300	- - .001 002	6 6 - 6	40 25 50 20 30	8 8 8 -5 5	2500-10,000 2500-10,000 2500-10,000 1000-2200 4500-12,500	- - - - 15	3-15 3-15 3-15 1.5-4.5 -(3-30)	18 18 18 18 18 72	
	2N3383 2N3608 2N3994 DE1004 M101	SI. GME TI GME SI	p,DP,F,3 p,M,4 p,DP,F,3 p,M,4 n,M,3	300 300 300 300 300 300(typ)	002 - 1.2 - 1	5 3 - 3.5 †7.5	30 *-30 25 *-20 20	5 *-6 1-5.5 *-8 -8	4500-12,500 800 (min) 4000-10,000 600 (min) 1500-3300	15 0.002 1.2 1000	-(3-30) 0.00003 (max) 2 (min) 0.0001 4-12	- 5 72 18 18	Flat pack
FET 5	F10049 2N3824 UC401 2N3966 HA2010	FA TI UC AL HU	p,DP,M,6 n,EP,F,3 p,F,3 n,DP,F3 p,M,4	270 250 250 250 220 200	0.001 0.1 .0001 0.001 1000	0.7 - 4 1.5	30 30 30 30 30 *-35	-6 8 8 6.0 *5	2000 (min) - - - 1000-2000	0.1 0.1 0.1 0.1	1000 - 8 (min) 2 (min)	72 72 72 18 72	UC
	U139D 2N3384 2N3385 2N3386 2N3993	SI SI SI TI	p,DP,F,6 p,DP,F,3 p,DP,F,3 p,DP,F,3 p,DP,F,3	200 180 180 150 150	002 002 002 0025 1.2	6 6 5 6	20 30 30 30 30 25	10 5 5 9.5 4-9.5	5000 (min) 7500-12,500 7500-12,500 7500-15,000 6000-12,000	10 15 15 15 15	-(4-50) -(15-30) -(15-30) -(15-50) 10 (min)	5 72 - 72 72 72	Dual Flat pack
FET 6	TIS05 2N3387 U139 UC451 2N3972	TI SI SI UC SI	p,DP,F,3 p,DP,F,3 p,DP,F,6 p,F,3 p,DPE,F,3	150 150 150 150 150 100	2 0025 0025 .90025 0.25	5 5 6 6 125	25 30 30 25 40	10 9.5 7 6 -3	6000-12,000 7500-15,000 7000 (min)	2 15 10 0.25 *0.25	10-45 -(15-50) -(9-35) 3.75-37.5 5-30	72 - 5 18 18	Flat pack Dual
	UC201 2N4093 CM600 UC251 TIXS42	UC AL CT UC TI	n,F,3 n,DP,F,3 n,EP,F,3 n,F,3 n,EP,F,3	100 80 75 75 70	.00025 .00002 3.0 .001 5	6 5.0 15 6	50 40 10 30 25	8 5.0 7 6 10		0.25 0.2 3 1	15 (min) 8 (min) - 7.5-75 10 (min)	72 18 18 18 18 92	
FET 7	2N3971 TIXS33 UC450 2N4092 CM601	SI TI UC AL CT	n,DPE,F,3 n,EP,F,3 p,F,3 n,DP,F,3 n,EP,F,3	60 60 60 50 50	.00025 1 .00025 .00002	†25 - 6 5.0 15	40 30 25 40 15	-5 10 10 7.0 10	12000 (min) - 10-30000	*0.25 - 0.25 0.2 3	25-75 25 (min) 25-75 15 (min)	18 72 18 18 18	

Key to FET listings

Definitions of parameters used appear in the article devoted to FET and MOS characteristics (pp. 94 to 102). In the column headed "Channel, construction, class and number of elements": channel refers to p or n type; classes F and M signify junction-FET and MOS-FET, respectively; construction is indicated by an abbreviated form of the manufacturing process (see page 20 for key to symbols); and number of elements designates the number of accessible leads on the package, e.g., 3 for FETs, 4 for tetrode FETs or MOSs, etc.

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	^r ds(on) [Mox.] (ohms)	ID(off) [Max.] (μΑ)	C _{dgs} or *C _{sgs} or †C _{iss} [Max.] (pF)	BVGSS or *BVDSS [Min.] (volts)	VGS (off) or *VGS(TH) [Max.] (volts)	9fs [MinMax.] (μmhos)	IGSS or *IDGO [max.] (nA)	IDSS [MinMax.] (mA)	TO-	Alternate Sources and Remarks
	CM602 TIXS36 U182 CM603 2N4091	CT TI SI CT AL	n,EP,F,3 n,EP,F,4 n,DPE,F,3 n,EP,F,3 n,DP,F,3	50 50 40 35 30	3.0 - .00025 3.0 .00002	15 - †25 15 5.0	30 30 40 15 40	10 10 -10 10	10-30000 10,000-20,000 - 20-60000	10 10 *0.25 3 0.2	- 10,000- 50-150 - 30 (min)	18 18 18 18 18	
FET 8	UC250 TIXS41 2N2386 2N2500 2N3332	UC TI TI Ti TI	n,F,3 n,EP,F,3 p,DP,F,3 p,DP,F,3 p,DP,F,3	30 25 - - -	.001 0.5 0.01 -	6	30 30 - -	10 10 8 15 6	- 1000 (min) 1000-2200 1000-2200	0.1 0.2 10 10	50-150 50 (min) - 1-6 1-6	18 18 5 5 72	
	2N3796 2N3797 2N3819 2N3820 2N3821	MO MO TI TI TI	n,DP,M,4 n,DP,M,4 n,EP,F,3 p,PL,F,3 n,EP,F,3	11.1	-	0.8 0.8 - -	*25 *25 25 20 50	-4 -4 8 8 4	900-1800 1500-3000 2000-6500 800-5000 1500-4500	-0.001 -0.001 2 20 0.1	0.5-3 4-6 2-20 0.3-15 0.5-2.5	18 18 92 92 72	
FET 9	2N3822 2N3823 2N3909 2N4220 2N4221	TI TI TI MO MO	n,EP,F,3 n,EP,F,3 p,PL,F,3 n,DP,F,3 n,DP,F,3	- - - -	- - -	- - 2 2	50 30 20 -30 -30	6 8 0.3-7.9 -4 -6	3000-6500 3500-6500 1000-5000 1000-4000 2000-5000	0.1 0.5 10 -0.1 -0.1	2-10 1-7.5 0.3-15 0.5-3 2-6	72 72 72 72 72 72	
7	2N4222 3N124 3N125 3N126 MFE2093	MO MO MO MO MO	n,DP,F,3 n,DP,F,3 n,DP,F,4 n,DP,F,4 n,DP,F,3	-		2 2 2 2 2 2	-30 -50 -50 -50 -50	-8 -2.5 -4.0 -6.5 -2.5	2500-6000 500-2000 800-2400 1200-3600 250-500	-0.1 -0.25 -0.25 -0.25 -0.1	5-15 0.2-2 1.5-4.5 3.0-9:0 0.1-0.7	72 72 72 72 72 72	
FET 10	MFE2094 MFE2095 TIS14 TIS34 TIXS35	MO MO TI TI	n,DP,F,3 n,DP,F,3 n,EP,F,3 n,EP,F,3 n,EP,F,4	- - - -	1 1 1	2 2 - -	-50 -50 30 30 30 30	-4.5 -5.5 6.5 1-8 1-5	350-700 400-800 1000-7500 3500-6500 10,000-20,000	-0.1 -0.1 1 5	0.4-1.4 1-3 0.5-15 4-20 10-50	72 72 72 72 92 72	

Type 1(b). Digital-switching: Listed by descending order of $V_{\rm GS(TH)}.$

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	VGS(TH) or *Vp [MinMax.] (volts)	rds (on) [Max.] ohms	I _{DSS} [MinMax.] (mA)	IGSS or *IDGO [Max.] (nA)	BVGSS *BVDSS or †BVDSX [Min.] (volts)	C _{rss} [Max.] (pF)	C _{iss} [Max.] (pF)	ton + toff [Max.] (µs)	TO-	Alternate Sources and Remarks
FET 11	2N2497 2N2498 2N2499 2N2500 2N3970	TI TI TI TI UC	p,DP,F,3 p,DP,F,3 p,DP,F,3 p,DP,F,3 n,F,3	15 (max) 15 (max) 15 (max) 15 (max) 10 (max)	1000 800 600 - 30	1-3 2-6 5-15 1-6 50-150	10 10 10 10 0.25	- - - 40	- - - - 6	32 32 32 32 32 25	- - - 50	5 5 5 5 18	
FFT 10	TIS05 TIXS33 TIXS41 TIXS42 2N2386	TI TI TI TI	p,DP,F,3 n,EP,F,3 n,EP,F,3 n,EP,F,3 p,DP,F,3	10 (max) 10 (max) 10 (max) 10 (max) 8 (max)	150 60 25 70	10-45 25 (min) 50 (min) 10 (min)	2 - 0.2 - 10	25 30 8 25	5 18 9	12 20 - 18 50	- 18 -	72 72 92 5	
FET 12	2N3331 2N3819 2N3820 2N3823 2N3824	TI TI TI TI	p,DP,F,3 n,EP,F,3 p,PL,F,3 n,EP,F,3 n,EP,F,3	8 (max) 8 (max) 8 (max) 8 (max) 8 (max)	600 - - - 250	5-15 2-20 0.3-15 1-7.5	10 2 20 0.5 0.1	25 20 30 50	- 4 16 2 3	20 8 32 6 6		72 92 92 72 72 72	
	TIS14 2N3330 2N3332 2N3631 2N3329	TI TI TI SI TI	n,EP,F,3 p,DP,F,3 p,DP,F,3 n,M,4 p,DP,F,3	6.5 (max) 6 (max) 6 (max) *-6 (max) 5 (max)	- 800 - 550 1000	0.5-15 2-6 1-6 2-10 1-3	1 10 10 - 10	30 _ _ _ 	1.6	8 20 20 7.5 20		72 72 72 72 18 72	
FET 13	2N3971 M101 M100 U182 2N3993	UC SI SI TI	n,F,3 n,M,4 n,M,4 n,DPE,F,3 p,DP,F,3	5 (max) *-8(max) *-5 (max) *-(4-10) 4-9.5	60 300 typ 350 (typ) 40 150	25-75 4-12 1.5-4.5 50-150 10 (min)	0.25 - *0.25 1.2	40 †20 †20 40 25	6 - 6 4.5	25 7.5 7.5 25 16	90 - - 50	18 18 18 18 72	
	2N3608 HA2000 2N3821 TIXS36 DE1004	GME HU TI TI GME	p,M,4 p,M,4 n,EP,F,3 n,EP,F,4 p,M,4	-(4-6) 4-5 4 (max) 3-10 -(3-8)	300 200 - 50 300	0.00003 	0.002 - 0.1 10 1000	-30 *-35 50 30 *-20	1 3 5 3	8 6 12 10	0.003	5 72 72 72 72 18	
FET 14	2N 4066 2N 4067 2N 4267 2N 4268 FI-0049	FA FA FA FA	p,EP,M,6 p,EP,M,6 p,EP,M,4 p,EP,M,4 p,EP,M,6	3-6 3-6 3-6 3-6 3-6 3-6	500 250 250 250 125 500	0.001 0.001 0.001 (max) 0.001 (max) 0.001 (max)	0.0025 0.0025 0.005 0.005 0.005	30 30 30 30 30 30	1.5 1.5 3 0.7 (typ)	7 7 15 15 0.5 (typ)	0.01 0.01 - - -	76 76 72 72 72	

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	V _{GS} (TH) or *V _P [MinMax.] (volts)	rds (on) [Max.] ohms	IDSS [MinMax.] (mA)	IGSS or *IDGO [Max.] (nA)	BVGSS * BVDSS or †BVDSX [Min.] (volts)	C _{rss} [Max.] (pF)	C _{iss} [Max.] (pF)	[†] on ^{+ †} off [Max.] (µs)	TO-	Alternate Sources and Remarks
	TIXS11 2N3972 FI-100 2N3971 2N3994	TI UC FA SI TI	p,PL,M,4 n,F,3 p,EP,M,4 n,DPE,F,3 p,DP,F,3	3-6 3 (max) 2.5-6.0 -2-5(Vp) 1-5.5	250-1000 100 1000 60 300	5-30 - 25-75 2 (min)	0.003 0.25 0.0025 *0.25 1.2	30 40 30 40 25	3 6 1.0 6 5	8 25 3.5 25 16	- 180 - 90 -	72 18 72 18 72	
FET 15	MM2103 TIXS35 TIS34 MM2102 2N3972	MO TI TI MO SI	p,DP,M,4 n,EP,F,4 n,EP,F,3 n,DP,M,3 n,DPE,F;3	-(1.5-5) 1-5 1-8 1-4 *-(0.5-3)	600 - - 200 100	0 -0.005 10-50 4-20 0-0.010 5-30	0.010 10 5 0.010 *0.25	*-25 30 30 *25 40	2.5 5 2 1.5 6	6.5 12 6 4.5 25	0.15 - 0.15 180	72 72 92 72 18	
	2N3909 2N3824 2N4065 2N4120 2N4220	TI MO FA FA MO	p,PL,F,3 n,DP,F,3 p,EP,M,4 p,EP,M,4 n,DP,F,3	0.3-7.9 - - - -	250 1500 1000	0.3-15 - 0.0005(max) 0.0005 (max) 0.5-3	10 -0.1 0.0025 0.0025 -0.1	20 -50 30 30 -30	16 3 0.7 0.7 2	32 6 4.5 4.5 6	0.65 0.65	72 72 72 72 72 72 72	
FET 16	2N4221 2N4222 3N124 3N125 3N126	MO MO MO MO MO	n,DP,F,3 n,DP,F,3 n,DP,F,4 n,DP,F,4 n,DP,F,4		11111	2-6 5-15 0.2-2.0 1.5-4.5 3.0-9.0	-0.1 -0.1 -0.25 -0.25 -0.25	-30 -30 -50 -50 -50	2 2 2.0 2.0 2.0 2.0	6 6 14 14 14		72 72 72 72 72 72	
FET 17	MFE2093 MFE2094 MFE2095	MO MO MO	n,DP,F,3 n,DP,F,3 n,DP,F,3			0.1-0.7 0.4-1.4 1.0-3.0	-0.1 -0.1 -0.1	-50 -50 -50	2 2 2	6 6 6	111	72 72 72 72	

Type 2(a). Low-drift, single-ended dc amplifiers: Listed by ascending order of $I_{\rm DX}$.

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	I _{DX} [MinMax.] (mA)	9fsx [MinMax.] (µmhos)	I _{GX} or *I _{GSS} [Max.] (nA)	BVGSS or *BVDSS [Min.] (volts)	VGSX or * Vp [MinMax.] (volts)	g _{os x} [Max.] (μmhos)	C _{iss} [Max.] (pF)	$\begin{array}{c} \text{NF} \\ \text{[Max.]} \\ \text{dB at } \text{(f=-kHz)} \\ \\ \text{R}_{\text{gen}} = - k\Omega \end{array}$	то-	Alternate Sources and Remarks
FET 18	2N3112 2N3113 2N2606 2N2841 2N2607	SI SI SI SI SI	p,DP,F,3 p,DP,F,3 p,DP,F,3 p,DP,F,3 p,DP,F,3	.008 (týp) .008 (typ) .01 (typ) .014 (typ) .03 (typ)	20 20 (typ) 40 (typ) 50 (typ) 120 (typ)	*0.05 *0.05 *1 - *3	20 20 30 30 30 30	0.4-3.5 0.4-3.5 0.4-3.5 1.2 (max) 0.4-3.5	11711	2 3.5 6 6 10	3(1/10000)	- 18 18 18 18	
FET 19	2N2842 2N2608 MFE2093 2N2843 3N124	SI SI MO SI MO	p,DP,F,3 p,DP,F,3 n,DP,F,3 p,DP,F,3 n,DP,F,4	.04 (typ) .1 (typ) 0.1-0.7 0.12 (typ) 0.2-2	150(typ) 370(typ) 250-500 450(typ) 500-2000	- *10 -0.1 - -0.25	30 30 -50 30 -50	1.2 (max) 0.4-3.5 -2.5 1.2 (max) -2.5	1.5	10 17 6 17 14	3(1/10000) - 3(1/1000)	18 18 72 18 72	
FE1 19	2N2609 2N3820 2N3909 2N2844 MFE2094	SI TI TI SI MO	p,DP,F,3 p,PL,F,3 p,PL,F,3 p,DP,F,3 n,DP,F,3	0.27 (typ) 0.3-15 0.3-15 0.4 (typ) 0.4-1.4	1200 (typ) 800-5000 1000-5000 1400 (typ) 350-700	*30 20 10 - -0.1	30 20 20 30 -50	0.4-3.5 8 (max) 0.3-7.9 1.2 (max) -4.5	- - - - 3,0	30 32 32 30 6	- - - 3(1/1000)	18 92 72 18 72	
FET 20	2N3969 2N3821 2N3796 2N4220 TIS14	AL TI MO MO TI	n,DP,F,3 n,EP,F,3 n,DP,M,3 n,DP,F,3 n,EP,F,3	0.4-2.0 0.5-2.5 0.5-3 0.5-3 0.5-15	1300 (min) 1500-4500 900-1800 1000-4000 1000-7500	0.1 0.1 -0.001 -0.1 1	30 50 *25 -30 30	*1.7 (typ) 4 (max) -4 -4 6.5 (max)	5.0 - 25 10	5.0 6 7 6 8	1.5(0.1/1000) 5(0.01,1000) - -	18 72 18 72 72 72	
PET 20	2N2497 2N3329 MFE2095 2N3968 2N2500	TI TI MO AL TI	p,DP,F,3 p,DP,F,3 n,DP,F,3 n,DP,F,3 p,DP,F,3	1-3 1-3 1.0-3.0 1.0-5.0 1-6	1000-2000 1000-2000 400-800 2000 (min) 1000-2200	10 10 -0.1 0.1 10	- -50 30 -	15 (max) 5 (max) -5.5 *3 (typ) 15 (max)	- 10 15 -	32 20 5 5.0 32	3(1/1000) - 1.5(0.1/1000)	5 72 72 72 18 5	
	2N3332 2N3823 3N125 2N3994 2N2498	TI TI MO TI TI	p,DP,F,3 n,EP,F,3 n,DP,F,4 p,DP,F,3 p,DP,F,3	1-6 1-7.5 1.5-4.5 2 (min) 2-6	1000-2200 3500-6500 800-2400 4000-10,000 1500-3000	10 0.5 -0.25 1.2	- 30 -50 25	6 (max) 8 (max) -4.0 1-5.5 15 (max)	- - 10 - -	20 6 14 16 32	1(1/1000) 2.5(100000/1) 	72 72 72 72 72 5	
FET 21	2N3330 2N3797 2N4221 2N3822 2N3819	TI MO MO TI TI	p,DP,F,3 n,DP,M,3 n,DP,F,3 n,EP,F,3 n,EP,F,3	2-6 2-6 2-6 2-10 2-20	1500-3000 1500-3000 2000-5000 3000-6500 2000-6500	10 -0.001 -0.1 0.1 2	- *25 -30 50 25	6 (max) -4 -6 6 (max) 8 (max)	- 60 20 - -	20 8 6 6 8	3-1-1000 - 5(0.01/1000)	72 18 72 72 72 92	мо
FET 22	2N3967 3N126 TIS34 2N2499 2N3331	AL MO TI TI TI	n,DP,F,3 n,DP,F,4 n,EP,F,3 p,DP,F,3 p,DP,F,3	2.5-10 3-9 4-20 5-15 5-15	2500 (min) 1200-3600 3500-6500 2000-4000 2000-4000	0.1 -0.25 5 10 10	30 -50 30 -	*2.0-5.0 -6.5 1-8 15 (max) 8 (max)	35 20 - - -	5.0 14 6 32 20	1.5(0.1/1000) - 4(1/1000)	18 72 92 5 72	
FEI 22	2N4222 3N98 TIXS35 3N99 TIXS36	MO RCA TI RCA TI	n,DP,F,3 n,DP,M,4 n,EP,F,4 n,DP,M,4 n,EP,F,4	5-15 7.7 (max) 10-50 10.5 40-200	2500-6500 1000-3000 10,000-20,000 1000-4000 10,000-20,000	-0.1 0.05 10 0.05 10	-30 *32 30 *32 30	-8 6 (max) 1-5 6 (max) 3-10	40 200 - 200	6 7 12 7 12	7(1/1000) 7(1/1000)	72 72 72 72 72 72 72	
FET 23	2N2386 HA2020 TIXS11	TI HU TI	p,DP,F,3 p,M,4 p,PL,M,3	=	1000 (min) 1000-2000 800 (min)	10 0 0.003	- *-35 30	8 (max) 80 (min) 3-6	-	50 8.0 8	2(5000/.05)	5 72 72	

Late-Arrivals. . .

The following silicon p-channel enhancement mode MOS-FETs, manufactured by General Instrument, are general-purpose ac amplifying units with characteristics similar to cross-index group FET 41:

MEM 511 MEM 520 MEM 517 MEM 550 MEM 517A MEM 551 MEM 517B

Use the literature offering and reader-service card (p. 5) to obtain detailed information on the parameters of these devices.

May 17, 1966

Type 2(b). Differential dc amplifiers: Listed by descending order of $\frac{\Delta |\textbf{V}_{GS}|}{\Delta |\textbf{T}|}$

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	\\V_GS\\ \times\T\\ [Max.] (\(\pu\)volts/\(^C\)	V _{GS1} -V _{GS2} [Max.] (volts)		Vp or * VGS (off) [Min Max.] (volts)	IGSS or *IGX [Max.] (nA)	I _{DSS} [MinMax.] (mA)	I _{G1} - I _{G2} [Max.] (nA)	9fsx [Min Max.] (μmhos)	то-	Alternate Sources and Remarks
FET 24	2N3336 2N3335 TIS27 2N3334 TIS26	TI TI TI TI	p,DP,F,6 p,DP,F,6 n,EP,F,6 p,DP,F,6 n,EP,F,6	520 280 210 200 140	0.050 0.040 0.015 0.020 0.010	20 20 50 20 50	0.3-1.6 0.3-1.6 6 (max) 0.3-1.6 6 (max)	10 10 0.25 10 0.25	0.3-1 0.3-1 0.5-8 0.3-1 0.5-8	200 100 10 50	600-1800 600-1800 1500-6000 600-1800 1500-6000	89 89 5 89 5	UC UC
FET 25	2N3609 3N97 2N3958 2N3333 2N3957	GME SI UC TI UC	p,M,4 p,DP,F,6 n,PL,F,6 p,DP,F,6 n,PL,F,6	110 106 100 80 75	0.1 0.2 0.025 0.015 0.020	*30 30 50 20 50	- 3.3 1.0-4.5 0.3-1.6 1.0-4.5	0.002 5 0.0001 10 0.1	35 -0.5-2.5 0.5-5.0 0.3-1 0.5-5.0	- 3 10 50 10	250-500 1000-3000 600-1800 1000-3000	5 5 71 89 71	
PET 25	TIS25 SU2079 SU2081 2N3935 2N3956	TI AL AL AL UC	n,EP,F,6 n,F,6 n,DP,F,6 n,DP,F,6 n,PL,F,6	70 60 60 50 50	0.005 0.015 0.015 0.005 0.005	50 50 50 50 50	6 (max) 4 (max) 4 (typ) 3 (typ) 1.0-4.5	0.25 0.25 0.5 0.1 0.1	0.5-8 0.25-2 1.0-10 0.25-1.3 0.5-5.0	10 - - - 10	1500-6000 300 (min) 1500 (min) 300 (min) 1000-3000	5 18 18 18 18 71	UC
FET 26	SU2078 SU2080 2N3922 2N3955 2N4083	AL AL UC AL	n,F,6 n,DP,F,6 n,DP,F,6 n,PL,F,6 n,DP,F,6	35 35 25 25 25	0.015 0.015 0.005 0.010 0.015	50 50 50 50 50	4 (max) 4 (typ) 3 (typ) 1.0-4.5 3 (typ)	0.25 0.5 0.25 0.0001 0.1	0.25-2 1.0-10 1.0-10 0.5-5.0 0.25-1.3	- - 10 -	300 (min) 1500 (min) 1500 (min) 1000-3000 300 (min)	18 18 18 71 18	
FE 1 26	2N4085 3N96 2N3921 2N3934 2N3954	AL SI AL AL UC	n,DP,F,6 p,DP,F,6 n,DP,F,6 n,DP,F,6 n,PL,F,6	25 13 10 10	0.015 0.1 0.005 0.005 0.005	50 30 50 50 50	3 (typ) 3.3 (typ) 3 (typ) 3 (typ) 1.0-4.5	0.25 5 0.25 0.1 0.0001	1.0-10 -0.5-2.5 1.0-10 0.25-1.3 0.5-5.0	1.0 - - 10	1500 (min) 250-500 1500 (min) 300 (min) 1000-3000	18 5 18 18 71	UC UC
FET 27	2N4082 2N4084 HA2030	AL AL HU	_n,DP,F,6 n,DP,F,6 p,M,4	10 10 -	0.015 0.015 0.005	50 50 35	3 (typ) 3.0 (typ)	0.1 0.25 -	0.25-1.3 1.0-10 0.000001	- 0	300 (min) 1500 (min) 1000-2000	18 18 72	

Type 3(a). General-purpose ac amplifiers: Listed by ascending order of $I_{\rm DSS}$.

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	I _{DSS} [MinMax.] (mA)	9fs [MinMax.] (µmhos)	Vp or *VGS (off) [MinMax.] (volts)	I _{GSS} [Max.] (nA)	BVGSS or *BVDSS or †BVDGO [Min.] (volts)	C _{iss} [Max.] (pF)	C _{rss} [Max.] (pF)	9 _{oss} [Mox.] (µmhos)	TO-	Alternate Sources and Remarks
FET 28	UC852 2N2841 DNX3 2N4117 2N3112	UC SI DIC SI	p,F,3 p,DP,F,3 n,DPE,F,3 p,DPE,F,3 p,DP,F,3	0.025 (min) -(.02512) 0.025-0.25 0.03-0.09 -(.035175)	60 60 (min) 200-700 60-170 50-115	6 (max) 1.7 (max) -2 (max) -0.7-2 1-4	2 1 -1.0 -0.01 0.05	25 - 50 40 20	6 6 - 3 3.5	1.5	- - - 3 -	18 18 18 72 72	UC
557.00	2N3113 UC750 2N3068 2N3367	SI UC AL	p,DP,F,3 n,F,3 n,DP,F,3 n,DP,F,3	-(.035175) 9.05 (min) 0.05-0.25 0.05-0.25	50-115 120 200-1000 100-1000	1-4 6 (max) 2,5 (max) 2,5 (max)	0.05 2 1.0 5	- 30 †50	2.0 6 10	-	=	- 18 18	Flatpáck DIC, UC, SI DIC, UC, SI
FET 29	2N3454 2N3457 2N3698 D1103	AL AL UC DIC	n, DP, F, 3 n, DP, F, 3 p, F, 3 n, DPE, F, 3	0.05-0.25 0.05-0.25 0.05-0.25 0.05-0.25	100-600 150-600 250-750 200-1000	2.5 2.5 0.3-1.2 -2.5 (max)	0.1 0.04 0.1 -10	†50 †50 30 25	6 5 5	1.5 1.2	=	18 18 72 18	UC, SI UC, SI
ET 30	D1179 DN3068A UC801 UC803 UC-41	DIC DIC UC UC UC	n,DPE,F,3 n,DPE,F,3 p,F,3 p,F,3 p,F,3	0.05-0.25 0.05-0.25 0.05-1.5 0.05-5.0 0.06-0.3	200-1000 200-1000 75-750 250-2500 100 (min)	-2.5 (max) -2.5 (max) 6 (max) 6 (max) 1-2.5	-5.0 -1.0 0.2 0.5 0.01	50 50 25 25 30	10 3 6 1.4	1.5 - - -	5	18 18 72 72 72 72	
E1 30	UC-43 UC853 2N2842 2N4118 C680	UC UC SI SI CT	p,F,3 p,F,3 p,DP,F,3 p,DPE,F,3 n,F,3	0.06-0.3 0.065 (min) -(.065325) 0.08-0.24 0.08-0.4	100 (min) 180 180 (min) 80-220 200-500	1-2.5 6 (max) 1.7 (max) -1.0-3.5 0.5-2.5	0.01 4 3 -0.01 1.0	30 25 30 40 30	1.4 10 10 3 5	- - 1.5 2	- - 5 -	- 18 18 72 5	UC
FT 21	C681 UC751 U1285 2N2606	CT UC AL SI	n,F,3 n,F,3 n,DP,F,3 p,DPE,F,3	0.08-0.4 0.1 (min) 0.1 (min) -(0.1-0.5)	200-500 350 200-1200 110-500	0.5-2.5 6 (max) 8.0 (max) 4 (max)	1.0 2 5.0 1.0	30 30 †30 –40	5 10 - 6	2	=	18 18 18 18	AL, DIC, UC
ET 31	2N3687 U114 2N3071 2N3370	UC SI AL AL	n,F,3 p,DP,F,3 n,F,3 n,DP,F,3	0.1-0.5 -(0.10-0.50) 0.1-0.6	500-1500 110 (min) 500-2500 300-2500	0.3-1.2 1-4 2.5 (max) 3.5 (max)	0.1 1 1.0 5.0	50 30 +50 +40	4.0 6 15	1.2 - 1.5	<u> </u>	72 46 18	DIC, UC, SI DIC, UC

Field-Effect (continued)

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	IDSS [MinMax.] (mA)	9fs [MinMax.] (μmhos)	Vp or * VGS (off) [MinMax.] (volts)	IGSS [Max.] (nA)	BVGSS or *BVDSS or †BVDGO [Min.] (volts)	C _{iss} [Max.] (pF)	C _{rss} [Max.] (pF)	g _{oss} [Max.] (µmhos)	TO-	Alternate Sources and Remarks
FFT.00	D1182 D1203 DN3071A DNX6 MFE2093	DIC DIC DIC DIC MO	n,DPE,F,3 n,DPE,F,3 n,DPE,F,3 n,DPE,F,3 n,DP,F,3	0.1-0.6 0.1-0.6 0.1-0.6 0.1-0.6 0.1-0.7	500-2500 300-1500 500-2500 500-2500 250-500	2.5 (max) -2.5 (max) -2.5 (max) 2 (max) *-2.5	5 10 -1.0 - -0.1	50 25 50 50 -50	15 6	2	7 1.5	18 18 18 18 18 72	
FET 32	DNX2 U110 UC850 UC701 U1280	DIC SI UC UC AL	n,DPE,F,3 p,DP,F,3 p,F,3 n,F,3 n,DP	0.1-1.0 -(0.1-1.0) 0.1-1 0.1-3.0 0.1-10	300-1000 110 (min) 110 150-1500 250 (min)	-4 (max) 1-6 6 (max) 6 (max) 10 (max)	-1.0 4 2 0.2 0.1	50 20 *20 40 +50	- 6 6 3	 	- - -	18 18 18 72 18	
FET 33	UC703 UC804 UC21 UC23 U1286	UC UC UC UC AL	n,F,3 p,F,3 n,F,3 n,F,3 n,DP	0,1-10 0,1-12 0,12-0,6 0,12-0,6 0.2 (min)	500-5000 500-5000 200 (min) 200 (min) 1000-10,000	6 (max) 8 (max) 1-2.5 1.0-2.5 8.0 (max)	0.5 0.5 0.1 0.01 10	40 25 30 30 †30	6 8 2.0 1.3	-		72 72 72 72 - 18	
FEI 33	UC854 2N3697 2N4119 2N2843	UC UC SI SI	p,F,3 p,F,3 p,DPE,F,3 p,DPE,F,3	0.2 (min) 0.2-0.6 0.20-0.60 -(0.2-1.0)	540 500-1000 100-250 540 (min)	6 (max) 0.6-2.0 -2.5-6.0 1.7 (max)	15 0.1 -0.01 10	25 30 40 30	17 5 3 17	1.2 1.5	10	18 72 72 72 18	UC
FET 34	2N3067 2N3366 2N3438 2N3453 2N3456 2N3460	AL AL AL AL AL	n,DP,F,3 n,DP,F,3 n,DP,F,3 n,DP,F,3 n,DP,F,3 n,DP,F,3	0.2-1.0 0.2-1.0 0.2-1.0 0.2-1.0 0.2-1.0 0.2-1.0	300-1000 250-1000 800-4500 150-900 300-900 800-4500	5 (max) 7 (max) 2.5 (max) 5 (max) 5 (max) 2 (max)	1.0 5.0 0.5 0.1 0.04 0.25	†50 †40 †50 †50 †50 †50	10 - 18 6 5 18	- - - 1.5	-	18 18 18 18 18 18	DIC, UC, SI DIC, UC, SI UC, SI UC, SI UC, SI UC, DIC, SI
FET 35	D1102 D1178 D1185 D1303 DN3067A	DIC DIC DIC DIC DIC	n,DPE,F,3 n,DPE,F,3 n,DPE,F,3 n,DPE,F,3 n,DPE,F,3	0.2-1.0 0.2-1 0.2-1.0 0.2-1.0 0.2-1.0	300-1000 300-1000 800-4500 800-4500 300-1000	-5 (max) -5 (max) -2 (max) -2 (max) -5 (max)	-10 -5.0 -5 -10 -1.0	25 50 50 25 50	- - - - 10	- - - 1.5	- - - - 20	18 18 18 18 18	
FEI 35	UC-40 UC-42 U1279 3N124 UC704	UC UC AL MO UC	p,F,3 p,F,3 n,DP n,DP,F,4 n,F,3	0.2-1.0 0.2-1.0 0.2-1.5 0.2-2.0 0.2-24	150 (min) 150 (min) 250 (min) 500-2000 1000-10,000	2-5 1.0-2.5 2.5 (max) *-2.5 8 (max)	0.01 0.01 0.1 -0.25 0.5	30 30 †50 –50 40	2.5 1.4 - 14 8	- - 2 -	- - - 2 -	72 - 18 72 72 72	
	U1284 2N3277 UC752 2N2607 U133	AL FA UC SI SI	n,DP p,EP,F,3 n,F,3 p,DP,F,3 p,DP,F,3	0.2-40 0.25 (typ) 0.3 (min) -(.30-1.5) -(0.30-1.5)	1000 (min) 150 (min) 1000 330 (min) 330 (min)	10 (max) 5 (typ) 6 (max) 1-4 1-4	0.5 0.1 6 3 3	†50 25 30 30 50	18 - 17 10 10		- - - - -	72 18 18 18	DIC, UC, AL
FET 36	2N3820 2N3909 UC814 UC805 2N3686	TI TI UC UC UC	p,PL,F,3 p,PL,F,3 p,F,3 p,F,3 n,F,3	0.3-15 0.3-15 0.3-15 0.3-25 0.4-1.2	800-5000 1000-5000 800-5000 1000-10,000 1000-2000	*8 (max) *0.3-7.9 8 (max) 8 (max) 0.6-2.0	20 10 2 1 0.1	20 20 25 25 50	32 32 16 12 4.0	16 16 8 - 1.2	-	92 72 72 72 72 72	SI, UC
	MFE2094 C682 C683 UC20 UC22	MO CT CT UC UC	n,DP,F,3 n,F,3 n,F,3 n,F,3 n,F,3	0.4-1.4 0.4-1.6 0.4-1.6 0.4-2.0 0.4-2.0	350-700 400-1000 400-1000 300 (min) 300 (min)	*-4.5 1.0-5.0 1.0-5.0 2.0-5.0 2.0-5.0	-0.1 1.0 1.0 0.01 0.01	-50 30 30 30 30 30	6 5 5 2.0 1.3	2 2 2	3.0 - - - -	72 5 18 72 -	
FET 37	UC855 2N2844 U1325 2N3696 2N3089 2N3089A	UC SI AL UC DIC DIC	p,F,3 p,DP,F,3 n,F,3 p,F,3 n,DPE,F,3 n,DPE,F,3	0.44 (min) -(0.44-2.2) 0.5 (typ) 0.5-1.5 0.5-2.0 0.5-2.0	1400 1400 (min) 500 (min) 250-1250 300-900 300-900	6 (max) 1.7 (max) 1.2 (max) 1-3.5 -5 (max) -5 (max)	50 30 0.1 0.1 -1.0 -1.0	25 30 - 30 40 40	25 30 - 5 14 14	1,2	 50 50	18 18 18 72 18 18	UC
FET 38	2N3070 2N3369 2N3821	AL AL TI	n,F,3 n,DP,F,3 n,DP,F,3	0.5-2.5 0.5-2.5 0.5-2.5	750-2500 600-2500 1500-4500	5 (max) 7 (max) *-4	1.0 5.0 -0.1	†50 †40 –50	15 - 6	1.5	- - 10	18 18 72	DIC, UC, SI DIC, UC, SI MO, UC
	3N89 D1181 D1202 DN3070A DNX5	SI DIC DIC DIC DIC	p,DP,F,4 n,DPE,F,3 n,DPE,F,3 n,DPE,F,3 n,DPE,F,3	-(0.5-2.5) 0.5-2.5 0.5-2.5 0.5-2.5 0.5-2.5	450-1300 750-2500 600-2000 750-2500 750-2500	3.3 (typ) 5 (max) -5 (max) -5 (max) 4 (max)	5 5 10 -1.0	30 50 25 50 50	3 - - 15 -		30	72 18 18 18 18 •18	

(see pages 4-9 for explanation of company abbreviations.)

May 17, 1966 109

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	I _{DSS} [MinMax.] (mA)	9fs [MinMax.] (µmhos)	Vp or *VGS (off) [MinMax.] (volts)	I _{GSS} [Max.] (nA)	BYGSS or *BYDSS or †BYDGO [Min.] (volts)	C _{iss} [Max.] (pF)	C _{rss} [Max.] (pF)	9 _{oss} [Max.] (µmhos)	TO-	Alternate Sources and Remarks
557.00	UC420 2N3796 2N4220 U1278 U89	UC MO MO AL SI	p,F,3 n,DP,M,3 n,DP,F,3 n,DP p,DP,F,4	0.5-2.5 0.5-3.0 0.5-3.0 0.5-3.0 -(0.5-5.0)	1500 (min) 900-1800 1000-4000 350 (min) 450-1300	2.5 (max) *-4 1-4 4.5 (max) 3.3 (typ)	0.1 -0.01 -0.1 0.1 10	30 -25 -30 +50 20	8 7 6 - 3	0.8 2 -	25 10 -	72 18 72 18 72	
FET 39	K1004 2N3822 TIS14 UC705 2N3376	KMC UC TI UC SI	n,M,4 n,F,3 n,EP,F,3 n,F,3	0.5-7.0 0.5-10 0.5-15 0.5-50	800 (min) 3000-6500 1000-7500 2000-20,000 800-2300	12 (max) 6 (max) *6.5 (max) 8 (max) 1-5	0.05 0.1 1 1 3	15 50 30 40 30	4.5 6 8 12 5	0.7 3 4 - 3	1000 - - - - -	18 72 72 72 72 72	
	2N3377 P1003 U168 2N3278 2N3084	SI AL SI FA CT	p,PL,F,3 p,DP,F,3 p,EP,F,3 n,F,3	0.6-6.0 -(0.6-6) 0.67.(typ) 0.8-3.0	800-2300 1000-3500 800 (min) 200 (min) 400-1200	1-5 3 (max) 5 (max) 8 (typ) -10	3 3 30 0.1 0.1	30 -50 20 25 30	4 20 65 - 5	2 - - 2	1	18 18 72 5	
FET 40	2N3085 2N3086 2N3087 2N3365 2N3066	CT CT CT AL AL	n,F,3 n,F,3 n,F,3 n,DP,F,3 n,DP,F,3	0.8-3.0 0.8-3.0 0.8-3.0 0.8-4.0 0.8-4.0	400-1200 400-1200 400-1200 400-2000 400-1000	-10 -10 -10 12 (max) 10 (max)	0.1 1.0 1.0 5.0 1.0	30 40 40 +40 +50	5 5 5 - 10	2 2 2 2 - 1.5	-	18 5 18 18 18	DIC DIC, UC DIC, UC, SI
	2N3437 2N3452 2N3455 2N3459	AL AL AL AL	n, DP,F, 3 n,DP,F, 3 n,DP,F, 3 n,DP,F, 3	0.8-4.0 0.8-4.0 0.8-4.0 0.8-4.0	1500-6000 200-1200 400-1700 1500-6000	5.0 10 (max) 10 (max) 4 (max)	0.5 0.1 0.04 0.25	†50 †50 †50 †50	18 6 5 18	- 1.5 5		18 18 18 18	UC, SI UC, SI UC, SI UC, SI
FET 41	D1101 D1177 D1184 D1302 DN3066A	DIC DIC DIC DIC DIC	n,DPE,F,3 n,DPE,F,3 n,DPE,F,3 n,DPE,F,3 n,DPE,F,3	0.8-4.0 0.8-4.0 0.8-4.0 0.8-4.0 0.8-4.0	400-2000 400-2000 1500-6000 1500-6000 400-1000	-10 (max) -10 (max) -4 (max) -4 (max) -10 (max)	-10 -5 -5 -10 -1.0	25 50 50 25 50	- - - - 10	- - - - 1,5	- - - - 50	18 18 18 18 18	
	DNX1 UC753 2N2608 2N3578 2N2386	DIC UC SI SI TI	n,DPE,F,3 n,F,3 p,DP,F,3 p,DP,F,3 p,DP,F,3	0.8-6 0.9 (min) - (0.90-4.5) - (0.9-4.5) - (0.9-9.0)	400-1500 2500 1000 (min) 1200-3500 1000 (min)	-8 (max) 6 (max) 1-4 1.5-4 8 (max)	-1.0 10 10 15 10	50 30 30 20 20	25 17 65 50		-	18 18 18 18 5	AL, UC
FET 42	U112 UC851 2N3328 UC807 2N3821	SI UC SI UC UC	p,DP,F,3 p,F,3 p,DP,F,3 p,F,3 n,F,3	-(0.9-9.0) 0.9-9 -1 (max) 1 (min) 1-2.5	1000 (min) 1000 100 (min) 2500-25,000 1500-4500	16 6 (max) 6 (max) 12 (max) 4 (max)	4 4 1 2 0.1	20 *20 20 20 50	17 17 4 30 6	- - - 3	-	18 18 72 18 72	UC
	2N2497 2N3329 MF E2095 2N3685 UC220	TI SI MO UC UC	p,DP,F,3 p,DP,F,3 n,DP,F,3 n,F,3 n,F,3	1-3 -(1-3) 1.0-3.0 1.0-3.5 1.0-5.0	1000-2000 1000-2000 400-800 1500-2500 3000 (min)	15 (max) *5 (max) *-5.5 1.0-3.5 2.5 (max)	10 0.01 -0.1 0.1 0.1	- -20 -50 50	32 20 6 4.0 7.0	- - 2 1.2	- 10 - -	5 72 72 72 72 72	SI, UC TI, UC
FET 43	2N2500 2N3332 2N3823 U1283 UC240	TI TI TI AL UC	p,DP,F,3 p,DP,F,3 n,EP,F,3 n,DP n,F,3	1-6 1-6 1-7.5 1.0-10 1.0-10	1000-2200 1000-2200 3500-6500 1500 (min) 1200 (min)	15 (max) 6 (max) *8 (max) 2.5 (max) 5.0 (max)	10 10 0.5 0.5 0.1	- 30 †50 50	32 20 6 18 18	- 2 -	- - -	5 72 72 18 18	UC UC UC
	2N3695 3N125 C684 C685 U1277	UC MO CT CT AL	p,F,3 n,DP,F,4 n,F,3 n,F,3 n,DP	1.25-3.75 1.5-4.5 1.5-6.0 1.5-6.0 1.5-8.0	1000-1750 800-2400 600-1500 600-1500 450 (min)	2-5 *-4.0 2.0-10 2.0-1.0 8.0 (max)	0.1 -0.25 1.0 1.0 0.1	30 -50 30 30 +50	5 14 5 5	1.2 2 2 2	10	72 72 5 18 18	
FET 44	2N2498 2N3330 2N4221 UC410 2N3069	TI SI MO UC AL	p,DP,F,3 p,DP,F,3 n,DP,F,3 p,F,3 n,F,3	2-6 -(2-6) 2-6 2-6 2-10	1500-3000 1500-3000 2000-5000 2250 (min) 1000-2500	15 (max) 6 (max) *-6 4 (max) 10 (max)	10 0.01 -0.1 0.1 1.0	- -20 -30 30 †50	32 20 6 8 15	- 2 - 1.5	- 20 -	5 72 72 72 72 18	SI, UC TI, UC DIC, UC, SI
	2N3822 2N2609 D1180 D1201	TI SI DIC DIC	n.EP.F.3 p,DP,F,3 n,DPE,F,3 n,DPE,F,3	2-10 -(2-10) 2-10 2-10	3000-6500 2500 (min) 1000-2500 1000-2500	*6 (max) 1-4 10 (max) -10 (max)	0.1 30 5 10	50 30 50 25	6 30 - -	3	= =	72 18 18 18	MO AL, UC
FET 45	DN 3069A DN X4 2N 3368 2N 3819	DIC DIC AL	n,DPE,F,3 n,DPE,F,3 n,DP,F,3 n,EP,F,3	2-10 2-10 2-12 2-20	1000-2500 1000-2500 1000-4000 2000-6500	-10 (max) 8 (max) 12 (max) *8 (max)	-1.0 - 5.0 2	50 50 †40	15 - - 8	4	80 - -	18 18 18	DIC, UC, SI

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	I _{DSS} [MinMax.] (mA)	9fs [MinMax.] (µmhos)	Vp or *VGS (off) [MinMax.] (volts)	I _{GSS} [Max.] (nA)	BVGSS or *BVDSS or †BVDGO [Min.] (volts)	C _{iss} [Max.] (pF)	C _{rss} [Max.] (pF)	9 ₀₅₅ [Max.] (µmhos)	TO-	Alternate Sources and Remarks
	P1004 U183 UC714 2N3684 UC707	AL SI UC UC UC	p,PL,F,3 n,DPE,F,3 n,F,3 n,F,3 n,F,3	2-20 2-20 2-20 2.5-7.5 2.5-250	2500-6000 2000-6500 2000-6500 2000-3000 5000-50,000	5 (max) -8 (max) 8 (max) 2-5 12 (max)	3 -2 1 0.1 2	-50 -25 30 50 20	20 8 8 4.0 30	- 4 4 1.2	50 - - -	18 72 72 72 72 18	
FET 46	2N2386 2N3378 2N3379 3N126 2N3436	TI SI SI MO AL	p,F,3 p,DP,F,3 p,DP,F,3 n,DP,F,4 n,DP,F,3	3 (typ) -(3-6) -(3-6) 3-9 3.0-15	1000-3000 1500-2300 1500-2300 1200-3600 2500-10,000	8 (max) 4-5 4-5 *-6.5 10 (max)	10 3 3 -0.25 0.5	20 30 30 -50 †50	5 4 14 18	3 2 2 -	20	5 72 - 72 18	SI, UC
	D1183 D1301 2N3458 2N3797 UC210	DIC DIC AL MO UC	n,DPE,F,3 n,DPE,F,3 n,DP n,DP,M,3 n,F,3	3-15 3.0-15 3.0-15 4-6 4-12	2500-10,000 2500-10,000 2500-10,000 1500-3000 4500 (min)	-8 (max) -8 (max) 8 (max) *-4 4.0 (max)	-5 -10 0.25 -0.001 0.1	50 25 †50 –25 50	- - 18 8 7.0	- - 0.8 -	- - 60 -	18 18 18 18 18 72	UC,SI
FET 47	TIS34 U1282 2N2499 2N3331 2N4222	TI AL TI TI MO	n,EP,F,3 n,DP p,DP,F,3 p,DP,F,3 n,DP,F,3	4-20 4.0-20 5-15 5-15 5-15	3500-6500 2500 (min) 2000-4000 2000-4000 2500-6000	1-8 4.5 (max) 15 (max) 8 (max) *-8	5 0.5 10 10 -0.1	30 50 - - -30	6 - 32 20 6	2 - - - 2	- - - 40	92 18 5 72 72	SI SI, UC
	UC400 P1005 U1281 UC200 TIXS35	UC AL AL UC TI	p,F,3 p,PL,F,3 n,DP n,F,3 n,EP,F,4	5-15 5-25 8 (max) 10-30 10-50	3000 (min) 3500-7000 250 (min) 6000 (min) 10,000-20,000	6 (max) 8 (max) 10 (max) 6.0 (max) *1-5	0.1 3 0.1 0.1 10	30 -50 †50 50 30	8 20 - 7.0 12	- - - 5	1	72 18 18 72 72	
FET 48	U146 2N2841 TIXS36 U147 2N2842	SI DIC TI SI DIC	p,DP,F,3 n,DPE,F,3 n,EP,F,4 p,DP,F,3 p,DPE,F,3	-25 (min) 25-125 40-200 -65 (min) -(65-325)	60 (min) 60-300 10,000-20,000 180 (min) 180-500	6 (max) 1.7 (max) *3-10 6 (max) 1.7 (max)	10 1.0 10 20 3	20 -40 30 20 -40	- 6 12 - 6	- 5 - -		18 18 72 18 18	UC
FET 49	U1287 U148 U149 2N3608 DE1004	AL SI SI GME GME	n,DP,F,3 p,DP,F,3 p,DP,F,3 p,M,4 p,M,4	100(typ) * * -	20,000 540 (min) 1400 (min) 800 (min) 600(min)	15 (max) 6 (max) 6 (max) *.4 (typ)	2.0 60 200 0.002 1000	30 20 20 *-30 *20	- - 8.0 10	- - 2.5 3	<u>:</u>	† 18 18 5 18	†MT25 package *loss (min.) = 0.2 *loss (min.) = 0.44
1 L 1 49	HA2001 TIXS11	HU TI	p,M,4 p,PL,M,3	Ξ	1000-2000 800 (min)	3-6	0 0.003	*35 30	8.0	1 3	_	72 72	

Type 3(b). Low-noise ac amplifiers: Listed by descending order of NF.

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	en nV/\Hz [M at (f=-kHz) * NF [Max.] (dB)	f=_kHz	9fs [MinMax.] (µmhos)	I _{DSS} [MinMax.] (mA)	BVGSS or *BVDSS [Min.] (volts)	IGSS [Max.] (nA)	C _{iss} [Max.] (pF)	V _P or *V _{GS} (off) [MinMax.] (volts)	ТО-	Alternate Sources and Remarks
FET 50	U168 2N3578 2N3458 2N3796 2N3797	SI SI SI MO MO	p,DP,F,3 p,DP,F,3 n,DPE,F,3 n,DP,F,3 n,DP,M,3	25/(1) 18/(1) *6 *5 *5	0.019 0.017 .02/1000 200000/- 200000/-	800 (min) 1200-3500 2500-10,000 900-1800 1500-3000	-(0.6-6.0) 0.9-4.5 3-15 0.5-3 4-6	20 20 - -25 -25	30 15 0.25 -0.001 -0.001	65 65 18 7 8	5 (max) 1.5-4 7.8 (max) -4(typ) -4(typ)	18 18 18 72 72	
	2N3821 2N3822 2N4220 2N4221 2N4222	TI TI MO MO MO	n,EP,F,3 n,EP,F,3 n,DP,F,3 n,DP,F,3 n,DP,F,3	*5 *5 *5 *5 *5	0.01/1000 0.01/1000 200000/- 200000/- 200000/-	1500-4500 3000-6500 1000-4000 2000-5000 2500-6000	0.5-2.5 2-10 0.5-3 2-6 5-15	50 50 -30 -30 -30	0.1 0.1 -0.1 -0.1 -0.1	6 6 6 6	*4 (max) *6 (max) -4(typ) -6(typ) -8(typ)	72 72 72 72 72 72	
FET 51	2N4223 2N3331 2N3455 2N3456 2N3457	MO TI SI SI SI	n,DP,F,3 p,DP,F,3 n,DPE,F,3 n,DPE,F,3 n,DPE,F,3	*5 *4 *4 *4 *4	200000/- 1/1000 .02/1000 .02/1000 .02/1000	3000-7000 2000-4000 400-1200 300-900 150-600	3-18 5-15 0.8-4.0 0.2-1.0 0.05-0.25	-30 - 50 50 50	-0.25 10 -0.04 -0.04 -0.04	6 20 5 5 5	*-1-7 *8 (max) -9.8 (max) -4.8 (max) -2.3 (max)	72 72 72 72 72 72 72	
	2N3460 2N3459 2N3088 2N3089 2N3329	SI SI CT CT TI	n,DPE,F,3 n,DPE,F,3 n,F,3 n,F,3 p,DP,F,3	*4 *3 *3 *3	.02/1000 .02/1000 .01/1000 .01/1000 1/1000	800-4500 1500-6000 300-900 300-900 1000-2000	0.2-1.0 0.8-4.0 0.5-2.0 0.5-2.0 1-3	50 50 15 15	0.25 0.25 1.0 1.0	18 18 5 5 20	1.8 (max) 3.4 (max) 5 (typ) 5 (typ) *5 (max)	18 18 5 18 72	
FET 52	2N3330 P-102 2N3452 2N3453 2N3454	TI SI SI SI	p,DP,F,3 p,DP,F,3 n,DPE,F,3 n,DPE,F,3 n,DPE,F,3	*3 *3 *2.0 *2.0 *2.0	1/1000 1/1000 .1/1000 .1/1000 .1/1000	1500-3000 1600 (typ) 200-1200 150-900 100-600	2-6 0.90-4.5 0.8-4.0 0.2-1.0 0.05-0.25	30 50 50 50	10 10 -0.1 -0.1 -0.1	20 17 6 6 6	*6 (max) 1-4 -9.8 (max) -4.8 (max) -2.3 (max)	72 18 72 72 72 72	

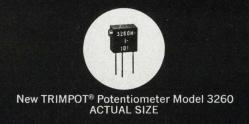
Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	en nV/\dag{Hz} [M at (f=-kHz) *NF [Max.] (dB)	$\begin{cases} i_n \\ \text{dax.} \end{cases} pA/\sqrt{Hz}$ $\begin{cases} f = -kHz \\ R_{gen} = -k\Omega \end{cases}$	gfs [MinMax.] (µmhos)	I _{DSS} [MinMax.] (mA)	BVGSS or *BVDSS [Min.] (volts)	IGSS [Max.] (nA)	C _{iss} [Max.] (pF)	Vp. or *VGS (off) [MinMax.] (volts)	TO-	Alternate Sources and Remarks
FET 53	2N3823 2N3823 2N3332 2N3088A 2N3089A	TI SI TI CT CT	n,EP,F,3 n,DPE,F,3 p,DP,F,3 n,F,3 n,F,3	*2.5 *2.5 *1 *0.5 *0.5	100000/1 .1/1000 1/1000 .01/1000 .01/1000	3500-6500 3200 (min) 1000-2200 300-900 300-900	1-7.5 4-20 1-6 0.5-2.0 0.5-2.0	30 30 - 15 15	0.5 -0.5 10 1.0 1.0	6 6 20 5 5	*8 (max) -8 (max) *6 (max) 5(typ) 5(typ)	72 72 72 72 5 18	
1 1 1 33	DN3066A DN3067A DN3068A DN3069A DN3070A	DIC DIC DIC DIC DIC	n,DPE,F,3 n,DPE,F,3 n,DPE,F,3 n,DPE,F,3 n,DPE,F,3	*0.25 *0.25 *0.25 *0.25 *0.25	1/1000 1/1000 1/1000 1/1000 1/1000	400-1000 300-1000 300-1000 1000-2500 750-2500	0.8-4.0 0.2-1.0 0.05-0.25 2-10 0.5-2.5	50 50 50 50 50	1.0 1.0 1 -1.0 -1.0	10 10 10 15 15	-(3.5-10) -(1.5-5) -(.4-2.5) -(2.5-10) -(1.0-5)	18 18 18 18 18	
	DN3071A 2N3695 2N3696 2N3697 2N3698	DIC UC UC UC UC	n,DPE,F,3 p,F,3 p,F,3 p,F,3 p,F,3	*0.25 0.20 0.20 0.20 0.20	1/1000	500-2500 1000-1750 750-1250 500-1000 250-750	0.1-0.6 1.25-3.75 0.5-1.5 0.2-0.6 0.05-0.25	50 30 30 30 30 30	-1.0 0.1 0.1 0.1 0.1	15 5 5 5 5	-(0.4-7.5) 2-5 1-3.5 0.6-2.0 0.3-1.2	18 72 72 72 72 72	
FET 54	2N3684 2N3685 2N3686 2N3687 UC240	UC UC UC UC	n,F,3 n,F,3 n,F,3 n,F,3 n,F,3	0.15 0.15 0.15 0.15 0.15 0.02		2000-3000 1500-2500 1000-2000 500-1500 1200 (min)	2.5-7.5 1-3.5 0.4-1.2 0.1-0.5 1-10	50 50 50 50 50	0.1 0.1 0.1 0.1 0.1	4 4 4 4 18	2-5 1-3.5 0.6-2.0 0.3-1.2 5-18	72 72 72 72 72 18	
	2N2386 2N2497 2N2498 2N2499 2N2500	TI TI TI TI	p;DP,F,3 p,DP,F,3 p,DP,F,3 p,DP,F,3 p,DP,F,3	11411		1000 (min) 1000-2000 1500-3000 2000-4000 1000-2200	1-3 2-6 5-15 1-6		10 10 10 10 10	50 32 32 32 32 32	8.(max) 15 (max) 15 (max) 15 (max) 15 (max)	5 5 5 5 5	
FET 55	2N3819 2N3820 2N3909 TIS14 TIS34	TI TI TI TI	n,EP,F,3 p,PL,F,3 p,PL,F,3 n,EP,F,3 n,EP,F,3			2000-6500 800-5000 1000-5000 1000-7500 3500-6500	2-20 0.3-15 0.3-15 0.5-15 4-20	25 20 20 30 30	2 20 10 1 5	8 32 32 8 6	*8 (max) *8 (max) *0.3-7.9 *6.5 (max) 1-8	72 72 72 72 72 72	
FET 56	TIXS11 TIXS35 TIXS36	TI TI TI	p,PL,M,3 n,EP,F,4 n,EP,F,4	=		800 (min) 10,000-20,000 10,000-20,000	10-50 40-200	30 30 30	0.003 10 10	8 12 12	3-6 *1-5 *3-10	72 72 72 72	

Type 3(c). High-frequency ($f \ge 1$ MHz) ac amplifiers: Listed by ascending order of g_{fs} .

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	9fs [MinMax.] (umhos)	C _{rss} [Max.] (pF)	C _{iss} [Max.] (pF)	giss [Max.] (µmhos)	BVGSS or *BVDSS [Min.] (volts)	I _{DSS} [MinMax.] (mA)	VP or * VGS (off) [MinMax.] (volts)	$\begin{array}{c} \text{NF} \\ [\max.] \\ \text{dB at (f=-kHz)} \\ \\ \hline R_{\text{gen}} = -k\Omega \end{array}$	ТО-	Alternate Sources and Remarks
FET 57	3N89 U89 DE1004 2N3608 TIXS11	SI SI GME GME TI	p,DP,F.4 p,DP,F,4 p,M,4 p,M,4 p,PL,M,3	450-1300 450-1800 600 (min) 800 (min) 800 (min)	- 3 2.5 3	3 3 10 8 8		30 30 *-20 *-30 30	-(0.5-2.5) -(0.5-5.0) 0.0001 0.00003	3.3(typ) 3.3(typ) - - 3-6		72 72 18 5 72	
	2N3376 2N3377 2N3820 K1001 K1201	SI SI TI KMC KMC	p,DP,F,3 p,DP,F,3 p,PL,F,3 n,M,4 n,M,4	800-2300 800-2300 800-5000 1000 (min) 1000 (min)	3 2 16 0.7 0.3	5 4 32 4.5 3.0	- - - 800 800	30 30 20 15 15	0.6-6 0.6-6 0.3-15 5-12 1-5	1-5 1-5 *8 (max) 6 (max) 5 (max)	- - 4.5 (200 MHz) 4.5 (450 MHz)	72 72 18 18	
FET 58	TIS14 2N3378 2N3379 2N3380 2N3381	TI SI SI SI SI	n,EP,F,3 p,DP,F,3 p,DP,F,3 p,DP,F,3 p,DP,F,3	1000-7500 1500-2300 1500-2300 1500-3000 1500-3000	4 3 2 3 2	8 5 4 5 4	= = = = = = = = = = = = = = = = = = = =	30 30 30 30 30 30	0.5-15 3-6 3-6 3-20 3-20	*6.5 (max) 4-5 4-5 5-9.5 5-9.5] 	72 72 FP 72 FP	
	2N4038 2N4039 2N3821 2N3819 2N4224	TRWS TRWS TI TI MO	n,DP,M,3 n,DP,M,3 n,EP,F,3 n,EP,F,3 n,DP,F,3	1500-3000 1500-3000 1500-4500 2000-6500 2000-7500	0.2 0.2 3 4 2	2.5 2.5 6 8 6	- - - - 800	*20 *20 50 25 30	0-0.1 0-0.1 0.5-2.5 2-20 2-20	0-2 -(2-6) *4 (max) *8 (max) *-(1-7.5)	3(100 MHz/1 MΩ) 3(100 MHz/1 MΩ) 5(0.01 KHz/1 MΩ) -	72 72 72 72 72 72	
FET 59	2N3822 2N4223 2N3823	TI MO TI	n,EP,F,3 n,DP,F,3 n,EP,F,3	3000-6500 3000-7000 3500-6500	3 2 2	6 6 6	800 -	50 30 30	2-10 3-18 1-7.5	*6 *-(1-7) *8 (max)	$\begin{array}{c} \text{5(0.01KHz/1M}\Omega) \\ \text{5(200MHz/1K}\Omega) \\ \text{2.5(100MHz/1K}\Omega) \end{array}$	72 72 72 72	SI, UC
	TIS34	TI	n,EP,F,3	3500-6500	2	6	-	30	4-20	1-8	-	72	
FET 60	K1003 FT57 TIXS35 TIXS36	KMC FA TI TI	n,M, 4 n,EP,M,4 n,EP,F,4 n,EP,F,4	4000 (min) 6000 (min) 10,000-20,000 10,000-20,000	1.0 0.8 5 5	3.5 2.7 12 12	800 60 (typ) - -	15 25 30 30	12-20 9-26 10-50 40-200	6 (max) 10 (max) *1-5 *3-10	4.5 (200 MHz) 4 at 0.1GHz/2.5KΩ 	18 72 72	

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Use the unijunction transistor that does

the job best. Listed by major parameters, these three charts facilitate selection.

Choice of the right unijunction transistor (UJT) for any application will save a lot of design and test time. To facilitate selection, ELECTRONIC DESIGN has separated the UJTs into three categories, each intended for a specific set of applications. The parameter definitions and test set-ups that follow provide a good understanding of how the UJT works, and show the relationship between application and UJT parameter specifications.

Within the limits of its relatively low frequency capabilities (a few hundred kilohertz at most), the UJT is ideal for such applications as relaxation oscillators, timing circuits, voltage and current level-sensing, frequency dividing, precision triggering of the SCR, SCS, and Triac, control of frequency for inverters and oscillators, and saw-

tooth and pulse generation.

The UJT data listings are organized according

to key design parameters. These are:

■ Type 1—for pulse applications such as SCR triggering; in order of increasing V_{OB1} (base-one peak-pulse voltage).

■ Type 2—for high-frequency, short timing period, and voltage-sensing applications; in order

of increasing I_v (valley current).

■ Type 3—for low-frequency, long timing period, and current-sensing applications; in order of decreasing values of I_P (peak-point current).

To select a UJT, many other factors should also be considered. These include circuit acceptance of parameter spreads, supply voltage requirements, frequency, ambient temperature range, power dissipation, current limitations, package type and size, and device cost.

Basic concepts explained

The UJT, a three-terminal semiconductor device, is distinctive by having a negative resistance characteristic which is highly stable with voltage, temperature and time. Fig. 1 shows the schematic symbol for the UJT as well as the relationship of the leads when the device is housed in a standard transistor can. By examining the simplified equivalent circuit shown in Fig. 2, the operation of this device can be easily visualized. Though different geometries exist, the UJT consists basically of a pellet of n-type silicon with ohmic

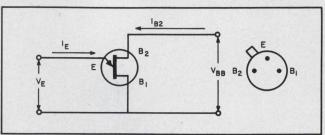
Dwight V. Jones, Applications Engineer, Semiconductor Products Dept., General Electric Co., Syracuse, N. Y.

contacts, base-one (B_1) and base-two (B_2) , at opposite ends of the pellet. At some point between these two, a single rectifying contact, the emitter (E), is attached. The interbase resistance, R_{BBO} , is the sum of R_{B_1} and R_{B_2} and is between 5 and 10

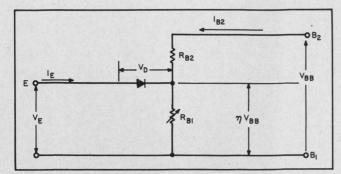
In the equivalent circuit, the diode (D) represents the UJT's emitter diode. In normal circuit operation, a positive bias voltage (V_{BB}) is applied at base-two. With no emitter current flowing, the silicon pellet acts as a simple voltage divider; a certain fraction, η , of V_{BB} appears at the emitter. If the emitter voltage, V_E , is less than ηV_{BB} , the emitter becomes reverse-biased and only a small emitter leakage current flows. If V_E is greater than η V_{BB} , the emitter is forward-biased and emitter current flows. This causes a decrease in the resistance between the emitter and base-one. As the emitter current increases, the emitter voltage decreases and a negative-resistance characteristic is obtained.

This characteristic is shown in Fig. 3 for a typical UJT. On this curve, the two major points of interest are the peak point and the valley point. To the left of the peak point is the cut-off region where the emitter is reverse-biased and only a small leakage current flows. To the right of the valley point is the saturation region where the dynamic resistance is positive. The negative resistance region lies between these two points.

A better understanding can come from examining the relaxation oscillator circuit, shown in Fig. 4a, which is basic to most UJT applications. At the beginning of each cycle the emitter is reversebiased and hence non-conducting. As the capacitor (C_T) is charged through the resistor (R_T) , the emitter voltage rises toward the supply voltage,



1. Unijunction transistor is represented by this symbol, where the emitter, base-one and base-two are identified by E, B_1 , and B_2 . The circular outline shows the pin relationships for a transistor type package.



2. Simplified equivalent circuit of a unijunction transistor aids device analysis. When $V_{\rm E}$ is larger than $_{\eta}$ $V_{\rm BB}$ + $V_{\rm D}$, the diode conducts, $R_{\rm B1}$ reduces in value, and a large emitter current flows.

 V_1 . When the emitter voltage reaches the peakpoint voltage, V_P , the emitter becomes forward-biased and the dynamic resistance between the emitter and base-one drops to a low value. Capacitor C_T then discharges through the emitter. When the emitter voltage reaches $V_{E(MIN)}$, as shown in Fig. 4b, the emitter ceases to conduct and the cycle is repeated. The minimum emitter voltage, $V_{E(MIN)}$, is approximately equal to 0.5 $V_{E(SAT)}$. If R_1 is zero, it is relatively independent of bias voltage, temperature and capacitance. For small values of R_1 and R_2 , the frequency of oscillation is:

$$f \approx \frac{1}{R_T C_T \ln (1/1 - \eta)}.$$
 (1)

The UJT relaxation oscillator is noteworthy for its ability to operate over a wide range of circuit parameters and ambient temperature. Several important conditions must be satisfied if this circuit is to operate satisfactorily. These are:

■ The load line. formed by resistor R_T , must intersect the emitter characteristic curve to the right of the peak point. This condition ensures that R_T can supply sufficient current to the emitter to trigger the UJT. This condition may be written:

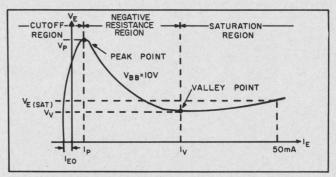
$$\frac{V_1-V_P}{R_T}>I_P.$$
 (2)

Generally I_P is specified at an interbase voltage of 25 volts and is inversely proportional to V_{BB} . This equation sets the maximum limit on R_T . R_T must be chosen to satisfy this inequality under the worst conditions for each of the other parameters. The worst conditions would include the maximum value of V_P , the minimum value of V_1 , and the maximum value of I_P at the minimum temperature of operation.

■ The load line formed by R_T must also intersect the emitter characteristic to the left of the valley point. This may be written:

$$\frac{V_1 - V_V}{R_T} < I_V. \tag{3}$$

Since V_v is circuit-dependent, its value should be measured in the actual circuit. If this condition is not satisfied, the load line will intersect the emitter-characteristic curve in the saturation region



3. Emitter characteristic curve shows the three operating regions. When the emitter diode goes into conduction, the device shifts its operating point through the negative resistance region to the saturation region.

and the UJT may not turn off after it triggers on the first cycle. Note that the value of valley current includes the effects of the base-one and basetwo external series resistors. If these are large, the value of I_v will be reduced as indicated in Fig. 5.

Finally the operation of the UJT relaxation oscillator greatly depends on the allowable range of capacitance C_T . As the size of C_T decreases from 0.01 to 0.001 μ F, the amplitude of the emitter waveform will decrease. This decrease is actually a function of the frequency capability of the UJT being used. For most UJTs the emitter peak current should not exceed two amperes for values of C_T less than 10 μ F and peak-point voltages less than 30 volts. For higher values of C_T or V_P , resistance should be used in series with the capacitor to protect the emitter circuit. This additional series resistance should be on the order of at least one ohm per microfarad of C_T .

In general the limitations imposed by the first two conditions are not severe. A maximum value of I_P might be 2 μ A and a minimum value of I_V might be 8 mA. The allowable range of R_T then would be 1000 to 1 or approximately 3 k Ω to 3 M Ω .

Defining the parameters

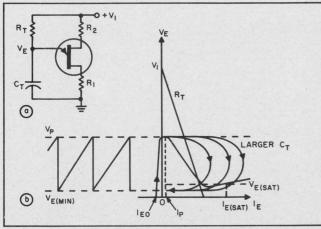
To properly select the device that will function best in any particular circuit, it is important to understand the meaning attached to each of the parameters and the methods by which these values can be checked in the laboratory. The following definitions and test circuits will greatly help in achieving a working design.

The intrinsic stand-off radio (η) , one of the most important parameters, is defined by the equation:

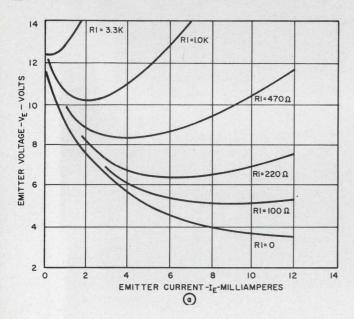
$$V_P = \eta \ V_{BB} + V_D,$$

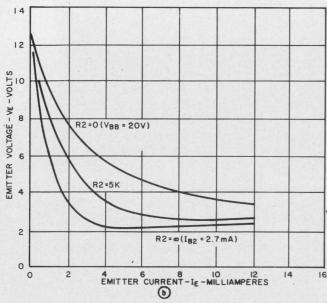
where V_P is the peak-point emitter voltage, V_{BB} is the interbase voltage, and V_D is the emitter diode's forward-voltage drop.

For a given UJT type, there is a range of values for the intrinsic stand-off ratio from device to device. Since the basic UJT circuit has a frequency characteristic which is dependent on R_T , C_T and η , a wide range of η will greatly affect the operating frequency of this basic oscillator. Though R_T can be adjusted to compensate for this

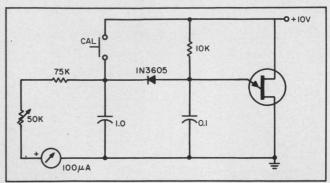


4. The basic unijunction circuit, a relaxation oscillator (a), provides a sawtooth output. The characteristic curve (b) shows the effect of increasing the value of the charging capacitor, $\mathbf{C_T}$.





5. Emitter characteristic curves, for a typical unijunction transistor, as a function of the base-one series resistance (a) and the base-two series resitance (b).



6. Test circuit for measuring the intrinsic stand-off ratio (η) uses a simple peak detector to measure the peak emitter voltage. Direct reading meter is set to read full scale by R_3 when the CAL button is pressed.

variation, in narrow-range and critical circuits, the use of a unijunction having a narrow range of η will greatly simplify the design, assure better temperature stability, and lower component cost. In addition, if the desired circuit is to operate with a low supply voltage, a UJT with a high value of η will permit a lower resistance value for the basetwo temperature-compensating resistor (R_2) . This results in a higher interbase voltage (V_{BB}) which increases the control range of the emitter timing resistor.

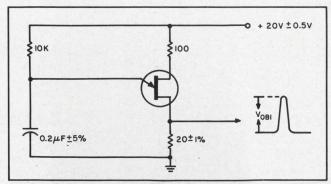
The circuit shown in Fig. 6 may be used to measure η . In this circuit R_1 , C_1 and the UJT form a relaxation oscillator. The remainder of the circuit serves as a peak-voltage detector. The diode automatically subtracts the emitter-diode voltage, V_D . To use the circuit, the "CAL" button is pushed and R_3 is adjusted until the meter reads full scale. The "CAL" button is then released and the value of η is read directly from the meter. To protect the unijunction, the power supply should have a current limit control.

The base-one peak-pulse voltage (V_{OB1}) is an important measurement when pulse generation is desirable or required. Essentially a circuit measurement, the use of a standard test circuit allows for easy comparison of various devices. The output of the circuit shown in Fig. 7 can be monitored with a scope to determine all of the pulse characteristics.

The valley current (I_v) is the emitter current at the valley point. This current will increase as the interbase voltage increases, and decrease with the resistance in series with base-one or base-two. Where fast response or high-frequency operation is desirable, this becomes an important parameter. Being circuit-dependent, this measurement should be made on the actual circuit.

The peak-point current (I_P) represents the minimum current which is required to trigger the UJT. It corresponds to the emitter current at the peak-point and is inversely proportional to the interbase voltage. In applications that require a high input impedance or a long timing period, this parameter becomes important while I_V does not.

The circuit shown in Fig. 8 is used to measure I_P . While observing the meter, the potentiometer setting is slowly increased until the UJT fires, as



7. Base-one peak-pulse voltage may be measured by putting a scope across $R_{\rm B_{\rm I}}$. This simple circuit may be used to compare the pulse capabilities of different UJTs. For SCR triggering, a large pulse is desirable.

evidenced by a sudden jump and oscillation of the meter needle. The current reading just prior to the jump is the peak-point current.

The emitter reverse current (I_{EO}) , similar to I_{CO} in a conventional transistor, can be measured by applying a voltage between base-two and the emitter, with base-one open-circuited. Unijunction transistors that have a guaranteed low I_P value generally also have a low leakage current. The stability of a UJT is improved as the ratio of the average capacitance-charging current to I_{EO} is increased.

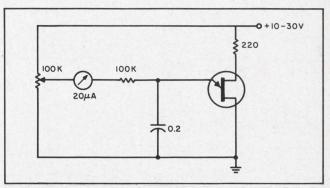
The interbase resistance (R_{BBO}) is the resistance measured between base-one and base-two, with the emitter open-circuited. By using devices that have a higher R_{BBO} rating, power dissipation can be decreased. This is important when higher values of interbase voltages are being used and the interbase power dissipation becomes an appreciable part of the total power dissipation. Since the interbase resistance has a positive temperature coefficient of 0.8%/°C, this characteristic can be used either for temperature compensation or in the design of temperature sensitive circuits. The value of the interbase resistance can be measured with any conventional ohm meter or resistance bridge, if the applied voltage is kept at five volts or less.

The emitter saturation voltage $(V_{E(SAT)})$ indicates the forward drop from emitter to base-one when the device is in the saturation region. Generally, it's measured at an emitter current of 50 mA and an interbase voltage of 10 volts. A low value of emitter saturation voltage will permit the generation of higher amplitude sawtooth voltages and also allow the use of lower supply voltages. In general, the higher the V_{OB1} rating a unijunction transistor has, the lower the saturation voltage will be.

The emitter reverse voltage (V_{EB2}) is the maximum voltage rating for the emitter junction. This rating should never be exceeded and thus restricts the choice of device to one that is compatible with the supply voltage being used.

Data list simplifies selection

Type 1—The UJT is an excellent trigger source



8. **Peak-point emitter current** is measured with this circuit. R_1 is increased until a jump in reading is observed on the meter. The current reading just before the jump is the peak-point emitter current.

firing silicon-controlled-rectifiers silicon-controlled-switches (SCS), and triode-acswitches (Triac). The trigger pulse generated may represent frequency control, time delay, amplitude level change, or phase control. The base-one peak pulse voltage, V_{OB1} , is the key parameter for these applications. The most desirable UJT types are those with the highest value of guaranteed minimum V_{OB1} . Unijunction transistors that feature high values of V_{0B1} are especially useful for triggering the higher-current SCRs. They are also preferred in circuits where the trigger supply voltage is low or where the size of the oscillator capacitance is limited. Many of the specification sheets will have trigger-circuit design curves which assure SCR triggering over a temperature range.

The minimum I_V specification should also be considered. High values of this parameter enable the circuit designer to use a low resistance for R_T without running into a "latch-on" problem. The lower value of R_T also increases the average charging current to the capacitance C_T ; this minimizes the effect of the temperature-sensitive leakage currents in the charging circuit.

Type 2—In designing circuits for high-frequency-control, short-timing-period and voltage-sensing applications, the minimum value of I_v , the valley current, is the key parameter.

Higher I_{ν} ratings allow the use of lower values of R_T . The result is a faster response time for any given capacitor size. Also, where large pulse outputs are required, the capacitor value may be increased. Finally, since I_{ν} decreases with supply voltage, the higher I_{ν} ratings are an advantage for low-supply-voltage applications.

Type 3—In low-frequency-control, long-timing-period, and current-sensing applications, the maximum value of I_P , the peak-point current, is the key design parameter. A low I_P permits longer time constants $(R_T C_T)$ in the emitter circuitry. This enables the designer to use smaller charging capacitors for a given timing period. These, in turn, will have lower leakage figures. Also, as the supply voltage decreases, the lower I_P rating helps to maintain a lower trigger-current requirement. This is an advantage in timing and level-sensing.

May 17, 1966

Unijunction

Type 1. Pulse Generation (e.g., SCR Triggering): In order of increasing values of VOB1

	Type Number	Orig. Reg.	Туре	V _{OB1} [min] (volts)	ly [min] (mA)	V _{EB2} [max] (volts)	η [min-max]	R _{BBO} [min] (kΩ)	l _p [max] (μA)	l _{E O} [max] (μA)	V _E (SAT) [max] (volts)	Alternate Sources and Remarks
	2N489A	GE	pn,si	3.0	8.0	60	0.51-0.62	4.7	12.0	2.0	4.0	TI, TO-5
	2N490A	GE	pn,si	3.0	8.0	60	0.51-0.62	6.2	12.0	2.0	4.0	TI, TO-5
	2N491A	GE	pn,si	3.0	8.0	60	0.56-0.68	4.7	12.0	2.0	4.3	TI, TO-5
	2N492A	GE	pn,si	3.0	8.0	60	0.56-0.68	6.2	12.0	2.0	4.3	TI, TO-5
	2N493A	GE	pn,si	3.0	8.0	60	0.62-0.75	4.7	12.0	2.0	4.6	ТІ, ТО-5
	2N494A	GE	pn,si	3.0	8.0	60	0.62-0.75	6.2	12.0	2.0	4.6	TI, TO-5
117	2N1671A	TI	pn,si	3.0	8.0	30	0.47-0.62	4.7	25.0	2.0	5.0	
JJT	2N1671B	GE	n,si	3.0	8.0	30	0.47-0.62	4.7	6.0	0.2	5.0	
1	2N2160	GE	pn,si	3.0	8.0	30	0.47-0.80	4.0	25.0	2.0	-	TI, TO-5
	2N2646	GE	pn,AE,si	3.0	4.0	30	0.56-0.75	4.7	5.0	12.0	2.0 (typ)	MO, TI
	SJ1034	TI	pn,si	3.0	_	30	0.50-0.80	4.0	-	15.0	_	T0-5
	SJ5898	ŤI	pn,si	3.0	2.0	30	0.55-0.80	4.0	5.0	0.01	4.0	T-69 (Plastic Planar)
	2N2647	GE	pn,si	6.0	8.0	30	0.68-0.82	4.7	2.0	0.20	2.0 (typ)	
and a	SJ1158	TI	pn,si	6.0	3.0	30	0.56-0.85	4.0	5.0	0.01	4.0	TO-18 (Planar)
1	SJ1159	TI	pn,si	6.0	4.0	30	0.65-0.85	4.7	2.0	0.01	4.0	TO-18 (Planar)

Type 2. High-Frequency Control, Voltage-Sensing, Frequency Dividing and Short Timing Periods: In order of increasing values of Iv

	Type Number	Orig. Reg.	Туре	ly [min] (mA)	η [min-max]	R _{BBO} [min] (kΩ)	I _{EO} [max] (μA)	l _P [max] (μ A)	V _{E(SAT)} [max] (volts)	V _{EB2} [max] (volts)	V _{OB1} [min] (volts)	Alternate Sources and Remarks
	2N3980	TI	pn,AE,si	1.0	0.68-0.82	4.0	0.01	2.0	3.0	30	6.0	MO
	SJ993	TI	pn,si	4.0	0.56-0.75	4.7	0.01	5.0	4.0	30	3.0	TO-18 (Planar)
	SJ1127	TI	pn,si	8.0	0.68-0.82	4.7	0.01	2.0	4.0	60	6.0	TO-18 (Planar)
	2N489	GE	pn,si	8.0	0.51-0.62	4.7	2.0	12.0	5.0	60	-	TI, TO-5
TLU	2N490	GE	pn,si	8.0	0.51-0.62	6.2	2.0	12.0	5.0	60	-	TI, TO-5
2	2N491	GE	pn,si	8.0	0.56-0.68	4.7	2.0	12.0	5.0	60	_	TI, TO-5
	2N492	GE	pn,si	8.0	0.56-0.68	6.2	2.0	12.0	5.0	60	_	TI, T0-5
	2N493	GE	pn,si	8.0	0.62-0.75	4.7	2.0	12.0	5.0	60	-	TI, TO-5
	2N494	GE	pn,si	8.0	0.62-0.75	6.2	2.0	12.0	5.0	60		TI, TO-5
	2N1671	TI	pn,si	8.0	0.47-0.62	4.7	12.0	25.0	5.0	30	-	T0-5

Type 3. Low-Frequency Control, Long Timing-Periods and Current-Sensing: In order of decreasing values of IP

	Type Number	Orig. Reg.	Туре	l _P [max] (μΑ)	EO [max] (μA)	η [min-max]	V _{OB1} [min] (volts)	R _{BBO} [min] (kΩ)	I _V [min] (mA)	V _{E(SAT)} [max] (volts)	V _{EB2} [max] (volts)	Alternate Sources and Remarks
	2N489B	GE	pn,si	6.0	2.0	0.51-0.62	3.0	4.7	8.0	4.0	60	TI, TO-5
	2N490B	GE	pn,si	6.0	2.0	0.51-0.62	3.0	6.2	8.0	4.0	60	TI, T0-5
	2N491B	GE	pn,si	6.0	2.0	0.56-0.68	3.0	4.7	8.0	4.3	60	TI, TO-5
	2N492B	GE	pn,si	6.0	2.0	0.56-0.68	3.0	6.2	8.0	4.3	60	TI, TO-5
	2N494B	GE	pn,si	6.0	2.0	0.62-0.75	3.0	6.2	8.0	4.6	60	TI, T0-5
UJT	2N495B	GE	pn,si	6.0	2.0	0.62-0.75	3.0	4.7	8.0	4.6	60	TI, TO-5
3	2N1671B	TI	pn,si	6.0	0.20	0.47-0.62	3.0	4.7	8.0	5.0	30	GE, TO-5
	2N490C	GE	n,si	2.0	0.02	0.62-0.91	3.0	6.2	8.0	4.0	60	
	2N492C	GE	n,si	2.0	0.02	0.62-0.91	3.0	6.2	8.0	4.3	60	
	2N494C	GE	pn,si	2.0	0.02	0.62-0.75	3.0	6.2	8.0	4.6	60	TI, TO-5
	2N1671C	GE	pn,si	2.0	0.02	0.47-0.62	3.0	4.7	8.0	5.0	60	
7,24	2N2647	GE	pn,si	2.0	0.20	0.68-0.82	6.0	4.7	8.0	2.0 (typ)	30	MO, TO-18 (Planar)
	2N3980	TI	pn,si	2.0	0.01	0.68-0.82	6.0	4.0	1.0	3.0	30	TO-18 (Planar)

(see pages 4-9 for explanation of company abbreviations.)



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developed and produced by one of the world's leading electrical organizations, employing 257,000 people—15,000 in R & D alone—manufacturing in 33 countries and represented in over 100.

include

Ferrite materials Capacitors Electron tubes Microwave tubes Rectifiers offer

advanced design, reliability, long life, versatility Siemens

metallized polyester capacitors

Small size and high reliability are new standards set by Siemens capacitors. Twenty years' experience in making metallized capacitors has resulted in advanced precision techniques which closely control every capacitor property, making them 100% "foolproof" in service.

Less than one breakdown (self-healing) per year and per mF—that is the consistent average shown by tests at nominal voltage.

Two-way self-healing gives double protection. Internal voltage breakdown very rarely occurs. If it does, the thin metal coatings at the breakthrough point, vaporize immediately, eliminating the breakthrough point within microseconds.

Electrochemical self-healing is the second protective process. It starts whenever and wherever insulation resistance decreases in the dielectric material and operates at any voltage, eliminating the point electrically.

Highly stable capacitance. Overload tests (at 2.2 nominal voltage and at 85°C) show negligible change of characteristics.

Small size—MKH (metallized polyester) capacitors are available with axial or radial leads, in flat compact form. Leads soldered to metallized ends ensure reliable contact.

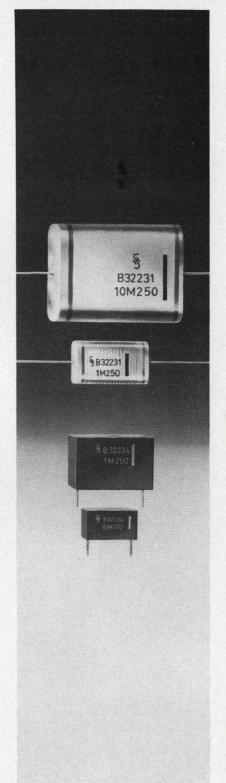
MKH properties. Operating temperatures: -40° to $+125^{\circ}$ C (for 1000 hours), $+100^{\circ}$ C for continuous operation. Insulation resistance: 20,000 megohms or 10,000 megohms X mF, whichever is lower. Dissipation factors: 0.5% at 1 kc; 1.5% at 10 kc (typical values).

Immediate shipment: Substantial stocks are held in White Plains, N.Y.

Write now for full information on Metallized Polyester Capacitors.

SIEMENS AMERICA INCORPORATED Components Division 230 Ferris Avenue, White Plains, N.Y.

In Canada: SIEMENS CANADA LIMITED 407 McGill Street, Montreal 1, P.Q.



How To Use The Cross Index

Types are listed in numerical sequence. EIA-registered types come first, followed by house-numbered types. The code following each type identifies its application category and the block of 10 types in which it is located. A3, for example, means the type can be found in the third block of the Audio section. Key to the letter codes is: A = audio and general-purpose, P = power, HF = high-frequency, LL = low-level switching, HL = high-level switching, FET = field-effect, UJT = unijunction.

2N35	A49	2N251A	P64	2N337	LL37	2N407	A30
2N94	HF2	2N257	P64	2N337A	LL13	2N408	A30
2N94A 2N102	HF3 A4	2N262	HF94	2N338 2N338A	LL37 LL16	2N409 2N410	HF5 HF5
2N102 2N104	A23	2N268 2N268A	P64 P64	2N339	P2	2N411	HF8
2N109	A32	2N270	A31	2N339A	A12	2N412	A32
2N117	A4	2N274	HF12	2N340	P2	2N414	LL10
2N118	A12	2N277	P85	2N340A	A12	2N418	HL40, P34
2N119	A24	2N278	P85	2N341	P2	2N419	P35
2N120	A37	2N279	A14	2N341A	P1, A12	2N420	HL40, P35
2N122 2N128	P22 HF17	2N280	A24	2N342 2N342A	P2 P2	2N420A	HL40, P35
2N139	HF3	2N281 2N282	A31 A31	2N342B	P2	2N424 2N424A	P61 HL41
2N140	HF8	2N284	LL37	2N343	P2	2N426	LL4
2N144	HF94	2N284A	LL37	2N343A	P2	2N427	LL7
2N156	P31	2N285A	P34	2N343B	P3	2N428	LL11
2N158 2N158A	P31 P31	2N285B	P34	2N344	HF12	2N441	P85
2N169	A27	2N297A	P64	2N345 2N346	HF12 HF20	2N442	P85
2N173	P84	2N301 2N301A	P26 P26	2N350A	P64	2N443 2N444	P85 HF1
2N174	P84	2N301A 2N306	A14	2N351A	P64	2N444A	HF1
2N174A	P84	2N315	LL6	2N356	LL4	2N445	HF2
2N175	A30	2N315A	LL6	2N356A	LL4	2N445A	HF2
2N176 2N178	P64 P64	2N315B	LL6	2N357 2N357A	LL7 LL7	2N446	HF3
2N211	HF3	2N316	LL12	2N358	LL11	2N446A	HF3
2N212	HF3	2N316A	LL12	2N358A	LL11	2N447 2N447A	HF8 HF8
2N213	A32	2N317 2N317A	LL15 LL15	2N370	HF20	2N447B	HF8
2N213A	A40	2N326	P22	2N371	HF13	2N449	A27
2N214	A25 A23	2N327A	LL1	2N372 2N374	HF13 HF94	2N456A	P51
2N215 2N217	A23 A32	2N328A	LL1	2N375	P65	2N456B	HL18
2N218	HF3	2N328B	LL1	2N376A	P65	2N457A	P51
2N219	HF8	2N239	LL1	2N384	HF30	2N457B	HL18 P52
2N219A	HL36	2N329A	LL1 LL2	2N388	LL6	2N458A 2N458B	HL18
2N220 2N231	A30 HF94	2N329B 2N330A	A12	2N388A 2N389	LL7 P61	2N463	P52
2N233	HF2	2N331	A50	2N393	HF15	2N470	A4
2N233A	HF2	2N332	A4	2N398	LL37	2N471	A4
2N234A	P34	2N332A	A3	2N398A	LL18	2N471A	HF6
2N235A	P34	2N333	A12	2N399	P34	2N472	A4
2N235B	P34	2N333A 2N334	A8 A19	2N400	P45 P34	2N472A 2N473	A4, HF6 HF6
2N236A 2N236B	P54 P54	2N335	A24	2N401 2N404	LL5	2N474 2N474	HF6
2N243	A7	2N335A	A19	2N404A	LL6	2N474A	HF7
2N244	A17	2N336	A38	2N405	A17	2N475	HF7
2N250A	P64	2N336A	A34	2N406	A17	2N475A	HF7

122 ELECTRONIC DESIGN

There is no adhesive like EASTMAN 910° Adhesive



SETS FAST—Makes firm bonds in seconds to minutes.

VERSATILE—Joins virtually any combination of materials.

HIGH STRENGTH—Up to 5,000 lb./in.² depending on the materials. **READY TO USE**—No catalyst or mixing necessary.

CURES AT ROOM TEMPERATURE—No heat required to initiate or

accelerate setting.

CONTACT PRESSURE SUFFICIENT.

LOW SHRINKAGE—Virtually no shrinkage on setting as neither solvent nor heat is used.

GOES FAR—One pound contains about 30,000 one-drop applications. (Or in more specific terms, approximately 20 fast setting one-drop applications for a nickel).

The use of EASTMAN 910 Adhesive is not suggested at prolonged temperatures above 175°F., or in the presence of extreme moisture for prolonged periods.

SHEAR STRENGTH OF BONDS

Bond Type	Time to Firm Set (minutes)	Representative Shear Strength† (psi)	Age of Bond	
Aluminum- Aluminum	2	1,484 2,188 2,700 2,800 (Tensile)	10 mins. 1 hr. 48 hrs. 24 hrs.	
Steel-Steel	2	1,362 2,224 2,800 5,030 (Tensile)	10 mins. 1 hr. 48 hrs. 48 hrs.	
Aluminum-Steel	10 1/2 (with surface activator*)	84 173 1,007 1,653	10 mins. 1 hr. 10 mins. 1 hr.	
Butyl Rubber-	1/2	511	10 mins.	
Butyl Rubber		63	4 yrs. ²	
Butyl Rubber-	1	521	10 mins.	
Steel		761	4 yrs. ²	
Butyl Rubber-	1	731	10 mins.	
Aluminum		691	4 yrs. ²	
SBR Rubber- SBR Rubber	1/2	901 561 881	10 mins. 4 yrs. ² 30 days, salt spray cycle (ASTM B 117-57T)	
Neoprene Rubber-	1/2	541	10 mins.	
Neoprene Rubber		45	4 yrs. ²	
Natural Rubber-	1/2	461	10 mins.	
Natural Rubber		39	4 yrs. ²	
SBR Rubber- Butyrate	1/2	951 1101 1121	10 mins. 2 yrs. ² 30 days, salt spray cycle (ASTM B117-57T)	
SBR Rubber-	1/2	1051	10 mins.	
Phenolic		1101	2 yrs. ²	
Butyl-	1/2	1021	15 mins.	
Polyester		154	2 yrs. ²	

Time to Firm Set (minutes)	Representative Shear Strength† (psi)	Age of Bond
1/2	114 ¹ 178 ¹	15 mins. 2 yrs. ²
1/2	1121 136	15 mins. 2 yrs. ²
1	327 1,400	10 mins. 48 hrs.
1	500 1,436 956 1,024	10 mins. 48 hrs. 1 yr. ⁴ 2 yrs. ⁴
1	747 600 ³	10 mins. 4 yrs.4
_ 1	647 920 348	10 mins. 48 hrs. 2 yrs.4
Polyester- 1 Stainless Steel		48 hrs. 6 mos.4 2 yrs.4
1	620 ³ 484 ³ 488	6 mos.4 1 yr.4 2 yrs.4
. 1	207 ³ 192 ³ 200 ³	6 mos.4 1 yr.4 2 yrs.4
2 1/2 (with surface activator*)	327 70 447 ³	10 mins. 1 yr. ² 10 mins.
2 2 2 (with surface	180 4113 (Flame treated polypropylene) 4013 (Flame-treated	24 hrs. 24 hrs. 15 mins.
	Firm Set (minutes) 1/2 1/2 1 1 1 1 1 1 2 1/2 (with surface activator*) 2 2 1/2	Firm Set (minutes) 1/2

†Laboratory test results

rubber failure

²weathered outdoors

3plastic failure

450% Relative Humidity and 75°F.

*In certain cases, most notably those involving polystyrene, pickled or dissimilar metal surfaces, bonding with EASTMAN 910 Adhesive is sometimes slow. EASTMAN 910 Surface Activator is designed to restore the rapid polymerization of the adhesive. It is also quite valuable in maintaining consistent results in production line bonding situations. Further information on this product is available.

Other materials that can be bonded successfully with EASTMAN 910 Adhesive are: polyurethanes, acetal resins; most hard woods; brass, copper. Recent work indicates that

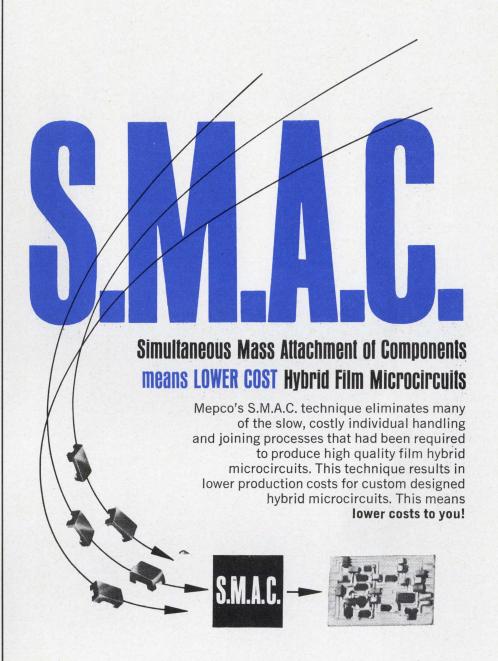
polyolefin and acetal plastic bonds are significantly improved by flame treatment of the plastic material prior to bonding (shear strengths up to $500~\rm psi$).

If you have applications in which extreme speed of setting is needed, or where design requirements involve small joining surfaces, complex mechanical fasteners, or heat sensitive assemblies, EASTMAN 910 Adhesive may save you many man-hours of production time. Send \$10 for a trial kit to use on your toughest bonding job. Kits and further information are available from Armstrong Cork Co., Industry Products Division, Lancaster, Pennsylvania, or from Chemicals Division, EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, Kingsport, Tennessee.

See Sweet's 1966 Product Design File 8a/Ea.

2N476	HF10	2N538A	P44	2N659 A22	2N741 HF73
2N477 2N478	HF10 HF11	2N539 2N539A	P44 P44	2N660 A30 2N661 A34	2N741A HF74 2N742 LL31
2N479	HF11	2N540 2N540A	P44 P44	2N662 A14 2N663 P46	2N743 HF96
2N479A 2N480	HF11 HF11	2N541	HF8	2N665 P46	2N743/46 HF89 2N743/51 HF89
2N480A	A21	2N542	HF9	2N669 P66 2N677 P66	2N744 LL38, HF96
2N489 2N489A	UJT2 UJT1	2N542A 2N543	HF9 HF9	2N677A P66	2N744/51 HF89
2N489B 2N490	UJT3 UJT2	2N543A 2N545	A35 HL26	2N677B P66 2N677C P66	2N752 HF50 2N753 HF96
2N490A	UJT1	2N546	HL26	2N678 P52	2N754 HF13
2N490B 2N490C	UJT3 UJT3	2N547 2N548	HL26 HL26	2N678A P52 2N678B P52	2N755 HF13 2N756 A5
2N491	UJT2	2N549	HL27	2N678C P52	2N756A A5
2N491A 2N491B	UJT1 UJT3	2N550 2N551	HL27 HL26	2N696 HL32, P7, HF27 2N697 P7, HF30	2N757 A8 2N758 A8
2N492	UJT2	2N552 2N554	HL26 P58	2N698 HL28, P12, HF21	2N758A A9 2N758B HF43
2N492A 2N492B	UJT1 UJT3	2N555	P58	2N699 HL32, P7, HF27 2N699B P15	2N759 A19
2N492C 2N493	UJT3 UJT2	2N563 2N564	A13 A13	2N700 HF80 2N700A HF90	2N759A A19 2N759B HF47
2N493A	UJT1	2N565	A27	2N702 LL22, HF43	2N760 A34
2N494 2N494A	UJT2 UJT1	2N566 2N567	A27 A38	2N703 LL22, HF43 2N705 LL37	2N760A A34 2N760B HF50
2N494B	UJT3	2N568	A38 A42	2N706 LL30, P3, HF74	2N768 HF40 2N769 HF84
2N494C 2N495	UJT3 HF7	2N569 2N570	A42	2N706/51 HF49 2N706A LL31, HF95	2N779A HF70
2N495B 2N496	UJT3 HF12	2N571 2N572	A45 A46	2N706A/51 HF49	2N780 A17 2N781 LL38, HF96
2N497	P14	2N574	P98 P98	2N706B LL31, HF74 2N706B/46 HF49	2N782 LL38, HF96 2N783 HF50
2N497A 2N498	P15 P14	2N574A 2N575	P98	2N706B/51 HF49 2N706C/46 HF49	2N784 HF65
2N498A	P15	2N575A 2N579	P98 LL10	2N706C/51 HF49	2N784A LL27, HF65 2N784/51 HF65
2N499 2N499A	HF57 HF57	2N580	LL13	2N707 LL31, P3, HF74 2N707A LL37	2N794 LL17, HF15
2N501 2N501A	HF29 HF39	2N581 2N582	LL10, HF7 LL15, HF11	2N708 HL39, LL31, P3,	2N795 LL17, HF15 2N796 LL18, HF18
2N502	HF80	2N583	LL10	HF75 2N709 LL35, P1, HF87	2N797 LL38, HF96
2N502A 2N502B	HF85 HF86	2N585 2N586	LL5 LL37	2N709/46 HF84 2N709/51 HF84	2N828 LL31, HF75
2N503 2N504	HF70 HF17	2N588 2N591	HF49 A31	2N709A HF88	2N828A HF75 2N829 HF75
2N508A	A39	2N594	LL4 LL5	2N709A/46 HF88 2N709A/51 HF88	2N834 LL29, HF78
2N511 2N511A	P85 P85	2N595 2N596	LL7	2N710 LL37, HF95	2N834/46 HF71 2N834/51 HF71
2N511B	P85	2N602 2N603	HF9 HF13	2N711 LL38 2N711A LL38	2N835 LL27, HF65, 80 2N835/46 HF65
2N512 2N512A	P85 P85	2N604	HF18	2N711B LL38 2N715 HF95	2N835/51 HF65
2N512B 2N513	P86 P86	2N605 2N606	HF18 HF18	2N716 HF95	2N838 LL27 2N840 HF13
2N513A	P86	2N607	HF18 HL2	2N717 HL30, P5, HF21 2N718 HL33, P5, HF27	2N841 HF15 2N842 LL16, HF13
2N513B 2N514	P86 P86	2N618 2N627	P65	2N718A HL33, P6, HF27 2N719 HL30, P5, HF21	2N843 LL17, HF16
2N514A	P86 P86	2N628 2N629	P65 P65	2N719A HL30, P6, HF21	2N844 HF18 2N845 HF18
2N514B 2N515	HF2	2N637	HL41, P65	2N720 HL33, P6, HF28 2N720A HL30, P6, HF21	2N846A HF70
2N516 2N517	HF2 HF3	2N637A 2N637B	HL41, P65 HL41, P65	2N721 HL31, P6	2N849/T1-430 LL38, HF96
2N519	LL2	2N638 2N638A	HL41, P65 HL41, P65	2N722 HL34, P6 2N725 LL38	2N850/T1-431 LL38, HF96
2N519A 2N520	LL2 LL5	2N638B	HL41, P66	2N726 A5 2N727 A14	2N851/T1-422 LL38,
2N521 2N522	LL10 LL13	2N647 2N649	A31 A30	2N728 HF30	2N852/T1-423 HF96 LL39,
2N522A	LL13	2N650 2N650A	A16 A16	2N729 HF30 2N730 HL42	2N858 HF96
2N523 2N523A	LL16 LL16	2N651	A26	2N731 HL42	2N859 LL7
2N524A 2N525A	LL16 LL16	2N651A 2N652	A26 A39	2N734 A9 2N735 A19	2N860 LL9 2N861 LL9
2N526A	LL17	2N652A	A39	2N735A HF47 2N736 A34	2N862 LL11 2N863 LL11
2N527A 2N528A	LL18 LL5	2N653 2N654	A16 A26	2N736A A28	2N864 LL14
2N529 2N530	A7 A11	2N655 2N656 HL4	A40 41, P14, HF94	2N736B HF49 2N738 A9, HF95	2N865 LL16 2N869 P3, HF50
2N531	A14	2N656A	P15 41, P14, HF95	2N739 A19, HF95	2N869A HF83 2N870 HL33, P7, HF28
2N532 2N533	A15 A18	2N657A	P15	2N739A HF47 2N740 A35, HF95	2N871 HL35, P7 HF30
2N538	P44	2N658	A14	2N740A HF50	2N909 HL31

2N910 2N911 2N912 2N914 2N914/	HL33, P7, HF28 HL32, P7, HF23 HL31, P7, HF21 P4, HF72 HF65 HL22, LL27,
	51 HF65 HL38, P4, HF66 HL39, P4, HF75 A24, HL40, LL35,
2N918 2N923 2N924 2N925 2N926 2N927 2N928 2N929 2N929A 2N930 2N930A 2N935 2N936 2N937 2N938 2N939 2N940 2N941 2N941 2N942 2N944 2N945 2N946	HF88 A24, LL36, HF89 A5 A12 A4 A11 A8 A28, HF97 HF57 A42, HF97 HF64 A19 A2 A7 A18 A2 A7 A18 LL14 LL11 LL3 LL3 LL3 LL3
2N947 2N955	HL38, P4, HF57 HF90
2N955A 2N956 2N957 2N960 2N961	LL36 HF30 A28, P2, HF57 LL33, HF79 LL33, HF79
2N962 2N963 2N964	HF79 HF66 LL33, HF79
2N964A 2N965 2N966 2N967 2N968 2N969	LL33, HF79 LL33, HF79 HF66 HF70 HF70
2N970 2N971 2N972 2N973 2N974 2N975 2N976	HF70 HF70 HF71 HF71 HF71 HF81
2N978 2N979 2N980	HL31, P4 HF30 HF30
2N982 2N983 2N984 2N985 2N987 2N988 2N989	HF78 HF78 HF72 LL39, HF91 HF31 HF66 HF66
2N989 2N990 2N993 2N995 2N996 2N997 2N998	HF26 HF26 P4, HF43 P4, HF57 A49 HF97
2N999 2N1000 2N1010 2N1011 2N1012	LL39 LL9 A17 HL42, P45 LL5



If your programs call for custom-designed film hybrid microcircuits, in high volume, at lower costs, and with faster delivery dates than you thought possible, then be sure to call Mepco . . . Ask about S.M.A.C. Find out how this new breakthrough in mass-producing film hybrid microcircuits can benefit your production plans.



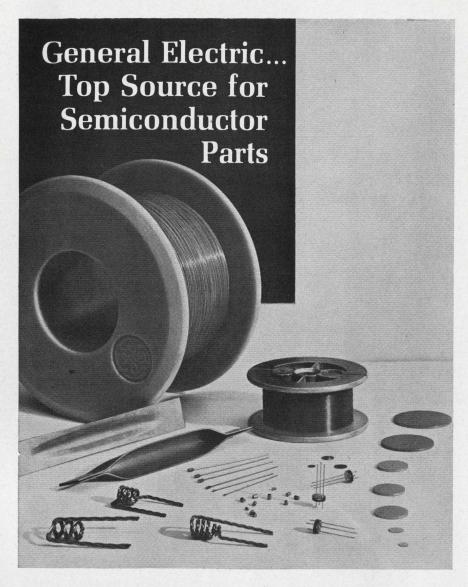
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ELECTRONIC DEVICES

2N1014 2N1015 2N1015A 2N1015B 2N1015C 2N1015D 2N1016E 2N1016A 2N1016B 2N1016C 2N1016B 2N1016E 2N1021 2N1022 2N1023 2N1024 2N1025 2N1026 2N1027 2N1028 2N1027 2N1028 2N1031 2N1031A 2N1031B 2N1031C 2N1032 2N1032A 2N1032A 2N1032B 2N1032B 2N1032B 2N1032C 2N1032B 2N1032C 2N1032 2N1032B 2N1032C 2N1034 2N1035 2N1036 2N1037 2N1038 2N1036 2N1037 2N1038 2N1038 2N1039 2N1040 2N1040 2N1041 2N1045 2N1046 2N1047	P52 HL11 HL11 HL11 HL11 HL11 HL11 HL11 HL1	2N1086 2N1086A 2N1087 2N1090 2N1087 2N1091 2N1097 2N1098 2N1099 2N1100 2N1101 2N1102 2N1116 2N1117 2N1118 2N1118A 2N1118A 2N1118 2N1120 2N1121 2N1122 2N1122A 2N1131 2N1132B 2N1132B 2N1136A 2N1136B 2N1137 2N1137B 2N1137 2N1137B 2N1138B 2N1138B 2N1138B 2N1138B 2N1138B 2N1138B 2N1139 2N1141 2N1146 2N1146 2N1146 2N1146 2N1146 2N1146	A45 A45 A45 LL7, HF4 A45 LL3 A28 A28 P86 P86 A15 A16 HL27 HL22 HF7 HF7 LL9 P51 A28 HF16 HF16 HS2, P8 LL18 HL18 HL19 P67 P67 P67 P67 P67 P67 P67 P67 P67 P67	2N1175A 2N1177 2N1178 2N1179 2N1180 2N1183 2N1183A 2N11844 2N1184B 2N1184 2N1184B 2N1188 2N1189 2N1190 2N1191 2N1192 2N1191 2N1195 2N1202 2N1203 2N1204 2N1204 2N1206 2N1207 2N1208 2N1201 2N1201 2N1201 2N1202 2N1203 2N1204 2N1204 2N1204 2N1204 2N1204 2N1204 2N1205 2N1202 2N1203 2N1204 2N1204 2N1206 2N1207 2N1208 2N1209 2N1211 2N1212 2N1212 2N1216 2N1211 2N1212 2N1216 2N1211 2N1212 2N1216 2N1211 2N1212 2N1212 2N1223 2N1224 2N1225 2N1226 2N1223 2N1224 2N1225 2N1223 2N1223 2N1224 2N1223 2N1223 2N1223 2N1223	HF42 HF42 HF42 HF42 HF41 P22 P22 P22 P22 P22 P22 A45 A16 A26 A39 A33 A41 A16 A23 A40 A45 LL34, HF83 P44 LL21 LL21 P12, HF9 P12, HF9 P12, HF9 P12, HF9 P12, HF9 P143 HL43 P55, 61 P55 HL26 LL39 P35 A8 A2 A1 HF13 HF13 HF13 HF13 HF13 LL39 LL39 LL39 LL39 LL39	2N1276 2N1277 2N1278 2N1279 2N1300 2N1301 2N1302 2N1303 2N1304 2N1305 2N1306 2N1306 2N1309 2N1309 2N1310 2N1311 2N1312 2N1319 2N1335 2N1336 2N1337 2N1338 2N1339 2N1340 2N1341 2N1342 2N1358 2N1358 2N1362 2N1363 2N1364 2N1365 2N1370 2N1371 2N1375 2N1376 2N1377 2N1378 2N1377 2N1378 2N1379 2N1377 2N1378 2N1377 2N1378 2N1377 2N1378 2N1379 2N1378 2N1379 2N1379 2N1379 2N1378	LL13
2N1032A 2N1032B 2N1032C 2N1034 2N1035 2N1036	P67 P67 P67 LL2 LL2 LL2	2N1132B 2N1136 2N1136A 2N1136B 2N1137 2N1137B	LL19 P67 P67 P67 P67 P67	2N1206 2N1207 2N1208 2N1209 2N1210 2N1211	P12, HF9 P12, HF9 HL43 HL43 P55, 61 P55	2N1342 2N1358 2N1359 2N1360 2N1362	P11, HF24 P87 P70 P70 P70
2N1038 2N1039 2N1040 2N1041 2N1042	HL42 HL42 HL42 HL42 P31	2N1138A 2N1138B 2N1139 2N1141 2N1141A	P68 P68 LL19 HF97 HF97	2N1212 2N1216 2N1218 2N1219 2N1220 2N1221	HL26 LL39 P35 A8 A2 A8	2N1364 2N1365 2N1370 2N1371 2N1372 2N1373	P70 P70 A20 A20 A9 A9
2N1044 2N1045 2N1046 2N1046A 2N1046B	P31 P31 HL42 HL42 HL42	2N1142A 2N1143 2N1143A 2N1144 2N1145	HF97 HF98 HF98 A36 A36	2N1223 2N1224 2N1225 2N1226 2N1228 2N1229	A1 HF13 HF31 HF13 LL39	2N1375 2N1375 2N1376 2N1377 2N1378	A20 A20 A28 A28 A33
		2N1146A 2N1146B 2N1146C 2N1147 2N1147A 2N1147B	P68 P68 P68 P68 P68 P68	2N1231		2N1380 2N1381 2N1382 2N1383 2N1384 2N1391	A9 A10 A20 A10 LL15 HF2
2N1049 2N1049A 2N1049B 2N1049C 2N1050 2N1050A 2N1050B	P48 P48 P48 P48 P48 P49 P49	2N1147C 2N1149 2N1150 2N1151 2N1152 2N1153 2N1154	P68 A5 A12 A19 A24 A38 A2	2N1239 2N1240 2N1241 2N1242 2N1243 2N1244 2N1247	HL43 HL43 HL43 HL43 HL44 HL44 HF98	2N1392 2N1393 2N1394 2N1395 2N1396 2N1397 2N1404	A50 A50 A3 HF13 HF31 HF39 LL41
2N1050C 2N1051 2N1052 2N1054 2N1055 2N1058	P49 A17, LL5 HF97 HF7 HL26 HF3	2N1155 2N1156 2N1157 2N1157A 2N1162 2N1162A	A2 A2 P98 P99 P69 P69	2N1248 2N1251 2N1252 2N1253	A5 A32 HL33, LL19, P8, HF28 HL36, LL21, P8, HF39	2N1404A 2N1408 2N1409 2N1410 2N1411	LL41 A3 HL15, P11, HF16, 18 HL15, P11, HF16, 18 HF12
2N1059 2N1060 2N1065 2N1066 2N1067 2N1068 2N1069	A25 LL16 HF12 HF39 P15 P23 P52	2N1163 2N1163A 2N1164 2N1164A 2N1165 2N1165A 2N1166	P69 P69 P69 P69 P69 P69 P69	2N1254 2N1255 2N1256 2N1257 2N1258 2N1259 2N1260	LL19 LL19 LL19 LL19 LL19 LL20	2N1412 2N1412US 2N1413 2N1414 2N1415 2N1417	P87 P87 A20 A28 A35 HF15
2N1070 2N1073A 2N1073B 2N1079 2N1080 2N1082	P53 HL43, P54 HL43, P54 HL43, P54 P55 A4	2N1166A 2N1166A 2N1167 2N1167A 2N1169 2N1170	P69 P70 P70 P70 LL6 LL6	2N1260 2N1261 2N1262 2N1263 2N1273 2N1274 2N1275	P61 P45 P45 P45 A9 A9 LL2	2N1418 2N1420 + 2N1427 2N1429 2N1430 2N1431 2N1439	HF15 HL35, P8, HF31 HF18 HF11 P53, 59 A33 A1

,	
2N1440 2N1441	A3 A8
2N1442	A16
2N1443 2N1444	A24
2N1444 2N1445	LL20 A10, P14
2N1469	A18
2N1474 2N1474A	A5 A8
2N1475	A19
2N1476 2N1477	A5 A14
2N1479	P15
2N1480	P16
2N1481 2N1482	P16 P16
2N1483	P35
2N1484 2N1485	P35
2N1486	P35
2N1487 2N1488	P59 P59
2N1489	P59
2N1490 2N1491	P59 HF58
2N1492	HF64
2N1493 2N1494	HF48, 66 LL21
2N1494A	LL21
2N1495 2N1496	LL22 LL22
2N1499	LL23
2N1499A 2N1499B	HF31, 46 HF44
2N1500	HF39
2N1501 2N1502	P45
2N1505 2N1506	P12, HF24
2N1506A	P12, HF43 P13, HF43
2N1507 2N1510	LL41, HF98 LL41
2N1511	P59
2N1512 2N1513	P59 P59
2N1514	P60
2N1518 2N1519	HL1 HL1
2N1520	HL1
2N1521 2N1522	HL1 HL1
2N1523	HL2
2N1524 2N1525	HF15 HF15
2N1526	HF15
2N1527 2N1529	HF15 P70
2N1529A	P70
2N1530 2N1530A	P71 P71
2N1531	P71
2N1531A 2N1532	P71 P71
2N1532A	P71
2N1533 2N1534	P71 P71
2N1534A	P71
2N1535 2N1536	P71 P72
2N1536A	P72
2N1537 2N1537A	P72 P72
2N1538	P72
2N1539 2N1539A	P72 P72
2N1540	P72
2N1540A	P72



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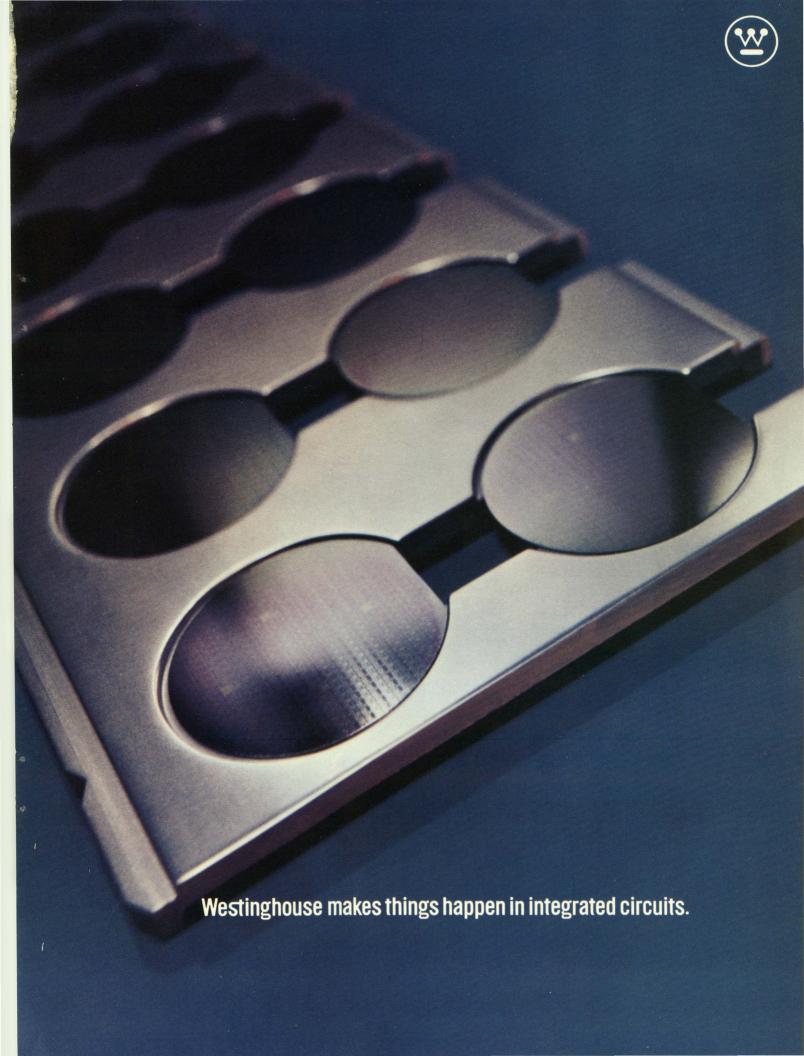
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2N1541	P72	2N1649	P49	2N1808	LL6	2N1990 HL4	44, P9, HF100
2N1541A	P73	2N1650	P49	2N1809	HL3, P106	2N1991	HL30, P9
2N1542	P73	2N1654	A15	2N1810	HL3, P106	2N1992	LL34
2N1542A	P73	2N1655	A6	2N1811	HL3, P106	2N1994 2N1995	LL42 LL42
2N1543	P73	2N1656 2N1666	A15 HL18	2N1812 2N1813	HL3, P106 HL3, P106	2N1996	LL42 LL42
2N1544 2N1544A	P73 P73	2N1667	HL18	2N1814	HL4, P106	2N1997	LL42
2N1544A	P73	2N1668	HL19	2N1816	HL6, P106	2N1998	LL42
2N1545A	P73	2N1669	HL19	2N1817	HL6, P106	2N1999	LL42
2N1546	P74	2N1671	UJT2	2N1818	HL6, P107	2N2000 2N2001	LL43 LL43
2N1546A	P74	2N1671A	UJT1	2N1819	HL6, P107	2N2001 2N2015	P87
2N1547 2N1547A	P74 P74	2N1671B 2N1671C	UJT1, 3 UJT3	2N1823 2N1824	HL8, P107 HL8, P107	2N2016	P87
2N1548	P74	2N1672	A10	2N1825	HL8, P107	2N2017	P16, 24
2N1549	P74	2N1672A	A3	2N1826	HL8, P107	2N2018	P49
2N1549A	P74	2N1676	LL14	2N1830	HL4, P107	2N2019	P49 P49
2N1550	P74	2N1677	LL14	2N1831	HL4, P107 HL4, P107	2N2020 2N2021	P50
2N1551 2N1551A	P74 P74	2N1683 2N1690	LL17, HF19 P49	2N1832 2N1833	HL4, P107	2N2038	
2N1551A	P74	2N1691	P49	2N1837	HL37, P8	2N2039	P1
2N1552A	P74	2N1692	P13	2N1838	HL35, P8	2N2040	P1
2N1553	P75	2N1693	P13	2N1839	HL35, P8	2N2041	P1
2N1553A	P75	2N1694	LL5 P16	2N1840	HL35, P9	2N2042 2N2042A	A11 A11
2N1554	P75 P75	2N1700 2N1701	HL13	2N1853 2N1854	LL41 LL17	2N2043	A22
2N1554A 2N1555	P75	2N1702	HL12	2N1864	HF19	2N2043A	A22
2N1555A	P75	2N1703	P60	2N1865	HF99	2N2048	LL25, HF44 HF44
2N1556	P75	2N1705	A32 A17	2N1866	HF99	2N2048A 2N2049	P13
2N1556A	P75 P75	2N1707 2N1708	LL23	2N1867	HF99	2N2060	HF22
2N1557 2N1557A	P75	2N1709	P27, HF44	2N1868 2N1893	HF99 HF19	2N2060A	HF22
2N1558	P76	2N1710	P27, HF40	2N1893A	HL36, P13,	2N2061A	P76
2N1558A	P76		L35, P13, HF31		HF32	2N2062A	P76
2N1559	P76	2N1714 2N1715	P23 P23	2N1899	HL29, P83	2N2063A 2N2064A	P76 P76
2N1559A	P76	2N1716	P24	2N1900 2N1901	P83, HF20 HL29, P83	2N2065A	P77
2N1560 2N1560A	P76 P76	2N1717	P24	2N1902	HL29, P83	2N2066A	P77
2N1561	P12, HF80	2N1718	P24	2N1903	P83, HF20	2N2067	P24
2N1562	P12, HF78	2N1719	P24	2N1904	HL29, P83	2N2067B 2N2067G	P24 P24
2N1564	A10, HF98	2N1720 2N1721	P24 P24	2N1905	P53	2N2067-0	P25
2N1565 2N1566	A20, HF98 A35, HF98	2N1722	P53	2N1906	P53 HL2, P55, HF9	2N2067W	P25
2N1566A	A33, 111 38	2N1722A	P53		HL3, P55, HF9	2N2068	P25
2N1572	A10, HF98	2N1723	P53	2N1917	LL41	2N2068G	P25 P25
2N1573	A20, HF98	2N1724	P53 P53	2N1918	LL41	2N2068-0 2N2075	P92
2N1574	A35, HF98	2N1724A 2N1725	P53	2N1919 2N1920	LL41 LL41	2N2075A	P92
2N1586 2N1587	A3 A3	2N1726	HF31	2N1920	LL41	2N2076	P92
2N1588	A3	2N1727	HF31	2N1922	LL42	2N2076A	P92 P92
2N1589	A13	2N1728	HF32	2N1924	A30	2N2077 2N2077A	P92
2N1590	A13	2N1742 2N1743	HF99 HF99	2N1925	A36	2N2078	P92
2N1591 2N1592	A13 A31	2N1743	HF99	2N1926	A41	2N2078A	P92
2N1593	A31	2N1745	HF99	2N1936 2N1937	P87 P87	2N2079	P93
2N1594	A32	2N1746	HF32	2N1943	P14	2N2079A 2N2080	P93 P93
2N1605	LL6	2N1747	HF32	2N1958	HF32	2N2080A	P93
2N1605A	LL6	2N1748 2H1748A	HF28 HF32	2N1958A	HF32	2N2081	P93
2N1613 HL 2N1614	34, P12, HF28 LL3	2N1749	HF28	2N1959	HF33	2N2081A	P93
2N1615	P16	2N1752	HF19	2N1959A 2N1960	HF33 HF100	2N2082 2N2082A	P93 P93
2N1616	P55	2N1754	LL22, HF99	2N1961	HF100	2N2084	HF32
2N1618	P55	2N1755 2N1756	P38	2N1962	HF50	2N2089	HF26
2N1620 2N1622	HL26, P55 A20	2N1757	P38 P38	2N1963	HF50	2N2092	HF24
2N1623	A13	2N1758	P38	2N1964 2N1965	HF33 HF33	2N2093	HF24 HF80
2N1631	HF17	2N1759	P38	2N1972	HL31, HF21	2N2095 2N2096	HF75
2N1632	HF17	2N1760	P38		L34, P13, HF28	2N2097	HF75
2N1637	HF17	2N1761 2N1762	P38 P39		HL32, P13, HF9	2N2098	HF80
2N1638 2N1639	HF16 HF17	2N1762 2N1768	HL15		L31, P13, HF22	2N2099	HF75 HF75
2N1640	LL2	2N1769	HL15		L29, P39, HF19 HL28, P9, HF14	2N2100 2N2102	LL20
2N1641	LL2	2N1785	HF19		HL28, P9, HF14	2N2102 2N2106	LL3, P3
2N1642	LL4	2N1786	HF19	2N1985 H	HL28, P9, HF14	2N2107	P3
2N1643	A3	2N1787 2N1788	HF19 HF32	2N1986	HL29, P9, HF19	2N2108	P3
2N1646 2N1647	HF99 P49	2N1789	HF32		HL29, P9, HF19 HL29, P9, HF20	2N2109 2N2110	HL4, P108 HL4, P108
2N1648	P49	2N1790	HF32		HL30, P9, HF20	2N2111	HL4, P108



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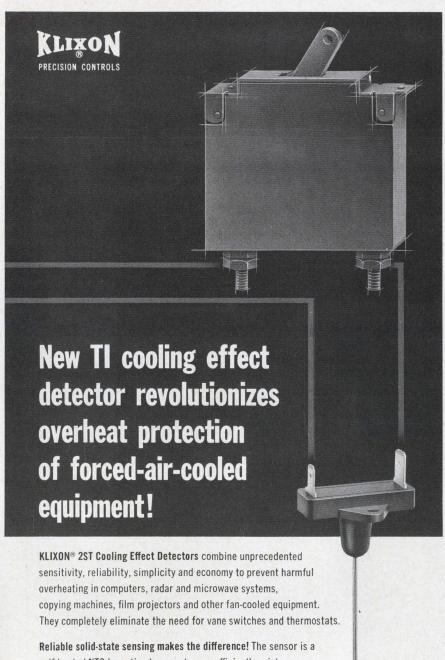
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2N2164 2N2165 2N2166 2N2167 2N2168 2N2169	LL16 LL11 LL11 LL14 HF79 HF79
2N2186 2N2187 2N2188 LL 2N2189 LL 2N2190 LL 2N2191 LL 2N2192A 2N2193A	LL9 LL9 43, HF29, 100 43, HF39, 100 43, HF39, 100 P11, HF100 HL36, P11, HF41
2N2194A 2N2195A	HL36, P11, HF41 HL36, P11,
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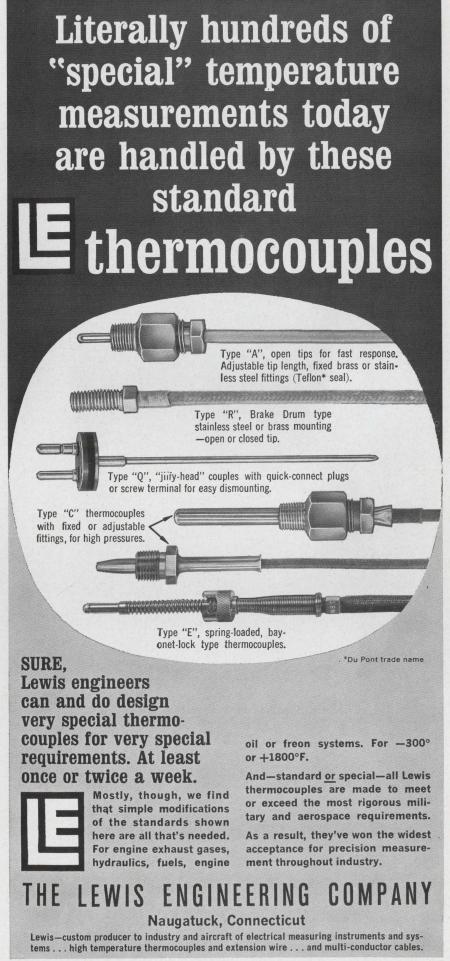
2N2230 HL2, P88 2N2231 HL2, P88 2N2232 HL2, P88 2N2233 HL2, P88 2N2234 HL3, P17 2N2244 A22 2N2360 HF100 2N2244 A22 2N2360 HF100 2N2246 A43 2N2361 HF101 2N2246 A43 2N2364 HL3, P17 2N2248 A36 2N2249 A43 2N2368 HL40, LL40,	2N2195A 2N2196 2N2197 2N2201 2N2202 2N2203 2N2204 2N2205 2N2206 2N2207 2N2217 2N2218 2N2218 2N2219A 2N2219 2N2219A 2N2221 2N2221A 2N2221A 2N2222 2N2223A 2N2223A 2N2223A 2N2225 2N2226 2N2227 2N2228 2N2228	HF41 P27 P28 P28 P28 P28 P28 P28 LL23 LL23 LL23 HF47 HL21, HF58 HF58 HL21, HF59 HL21, HF66 HF21, HF60 HF60 HF60 HF60 HF40 HF40 HF40 HF40 HF40 HF40 HF40 HF4	2N2295 2N2296 2N2297 2N2303 2N2304 2N2308 2N2310 2N2311 2N2312 2N2313 2N2314 2N2315 2N2316 2N2317 2N2318 2N2319 2N2320 2N2330 2N2331 2N2349 2N2350 2N2350 2N2350A 2N2351 2N2351A	HL45, P56 HL45, P56 HL45, P56 P17 P10 A13 P35 HL16 HL16 HL16 HL16 HL16 HL16 HL16 HL16	2N2416 2N2423 2N2427 2N2428 2N2429 2N2430 2N2431 2N2432 2N2451 2N2453 2N2455 2N2455 2N2460 2N2461 2N2462 2N2464 2N2464 2N2465 2N2464 2N2465 2N2466 2N2475 2N2476 2N2476 2N2477 2N2480 2N2480 2N2481 2N2482	HF102 P77 HF20 A41 A46 A30 A36 HF12 HF28 A44 A44 HL40 HF47 HF50 HF57 HF60 HF47 HF51 HF57 HF60 LL25, 34 LL25, HF60 HF94 HF94	2N2563 2N2564 2N2565 2N2569 2N2570 2N2580 2N2581 2N2582 2N2586 2N2590 2N2591 2N2592 2N2593 2N2595 2N2595 2N2596 2N2597 2N2598 2N2599 2N2599 2N25994 2N2599A 2N2600 2N2600 2N2601 2N2602 2N2603 2N2604 2N2605	P32 HL2 HL2 LL20 L20 P98 P98 P98 P98 A42 HF27 HF33 HF40 HF44 HF22 HF29 HF39 HF22 HF29 A15 HF39 A29 HF22 HF29 HF39 HF22
\$\frac{5}{2}\frac{2}{2}\frac{2}{3}\frac{1}{4} \frac{1}{1} \frac{1}{2}\frac{2}{2}\frac{2}{3}\frac{2}{3}\frac{2}{3}\frac{1}{2}\frac{2}{3}\frac{2}\frac{2}{3}\frac{2}{	2N2222 2N2222A	HL22, HF60 HF66	2N2331 2N2349	LL23, HF33 LL14	2N2465 2N2466	HF57 HF60	2N2599 2N2599A	HF29 A15
2N2227	2N2223A 2N2225	HF20 HF14	2N2350A	HL37, P17, HF41	2N2476 2N2477	LL25, HF60 HF60	2N2600A 2N2601	A29 HF22
Name	2N2227 2N2228	HL3, P87 HL3, P87	2N2351A	HL37, P17, HF41	2N2480A 2N2481	HF80 HL22	2N2603 2N2604	HF4 HF4
Name	2N2230	HL2, P88	2N2352A	HL37, P17, HF41	2N2483 2N2485	HF23 HF102	2N2606 2N2607	FET18, 3
2N2239 P28 2N2243A H136,P11, 2N2358 H145, P95 2N2494 HF48 2N2614 A46 2N2244 A22 2N2360 HF100 2N2495 HF48 2N2616 A24 2N2245 A35 2N2361 HF100 2N2495 HF48 2N2617 A13 2N2246 A33 2N2362 HF101 42,55 2N2247 A22 2N3360 HF100 2N2497 FET2, 11, 20, 2N2618 HF51 2N2247 A22 2N3364 H137, P17, 2N2498 FET2, 11, 20, 2N2618 HF51 2N2247 A22 2N3264A H137, P17, 2N2498 FET2, 11, 21, 2N2631 P23 2N2248 A36 H440, L140, 2N2499 FET3, 11, 22, 2N2631 P50 2N2249 A43 2N2368 H140, L140, 2N2499 FET3, 11, 22, 2N2633 P50 2N2250 A22 2N2369 H140, L135, 2N2500 FET8, 11, 20, 2N2635 P50 2N2251 A36 P4, H586 2N2501 H572 2N2636 P50 2N2252 A43 2N2369 H140, L135, HF86 2N2252 A43 2N2369 A L135, HF86 2N2501 HF72 2N2646 UJT1, 3 2N2254 A36 2N2370 A66 2N2509 HF17 2N2649 HF102 2N2256 LL29, HF71 2N2373 A10 2N2510 HF17 2N2650 HF102 2N2256 LL29, HF71 2N2373 A10 2N2510 HF17 2N2650 HF102 2N2258 LL29, HF71 2N2373 A10 2N2510 HF17 2N2650 HF102 2N2258 LL29, HF71 2N2373 A10 2N2510 HF17 2N2656 HF63 2N2258 LL29, HF71 2N2373 A10 2N2510 HF47 2N2656 HF63 2N2258 LL29, HF71 2N2373 A10 2N2510 HF47 2N2656 HF63 2N2258 LL29, HF71 2N2373 A10 2N2510 HF47 2N2656 HF63 2N2258 LL29, HF71 2N2373 H76 2N2515 HF47 2N2656 HF63 2N2258 LL29, HF71 2N2373 H76 2N2518 HF47 2N2657 P14 2N2257 LL8, HF4 2N2388 H61 2N2520 HF44 2N2673 A3 2N2277 LL8, HF4 2N2388 FET8, 12, 23, 2N2522 HF51 2N26675 A19 2N2277 LL8, HF4 2N2389 A18, HL45, HF101 2N2520 HF44 2N2677 LL12 2N2277 LL8, HF4 2N2389 A18, HL45, HF101 2N2525 P30, HF66 2N2698 P33 2N2279 LL10 2N2381 H60 2N2389 H146, HF101 2N2525 P31 2N2707 A42 2N2288 H144, P77 2N2399 HF101 2N2555 P32 2N2714 A33 2N2286 H144, P77 2N2399 HF101 2N2555 P32 2N2714 A33 2N2286 H144, P77 2N2399 HF101 2N2555 P32 2N2714 A33 2N2288 H144, P78 2N2400 HF60 2N2555 P32 2N2714 A36 2N2288 H144, P78 2N2400 H660 2N2555 P32 2N2714 A36 2N2288 H144, P78 2N2401 H146, HF101 2N2550 H22 2N2223 HF102 2N2290 H144, P56 2N2410 H146, HF101 2N2550 H22 2N2723 HF102 2N2291 H145, P56 2N2410 H146, HF101 2N2550 H22 2N2723 HF102 2N2292 H145, P56 2N2410 H146, HF101 2N2550 H22 2N2723 HF102	2N2232 2N2233	HL2, P88 P88	2N2353A	HL37, P17, HF41	2N2487	HF74	2N2609 2N2611	FET19, 4 P2:
Name	2N2239	HL36, P11,	2N2358 2N2359	HL45, P95	2N2494	HF48	2N2614 2N2616	A46 A24
Care	2N2245	A35 A43	2N2361 2N2362	HF101 HF101		FET2, 11, 20, 42, 55	2N2618 2N2618/4	HF51 HF51
Page	2N2248	A36		HF42		44, 55	2N2632	P50
2N2255	2N2250	A22 A36		P4, HF83 HL40, LL35,		47, 55 FET8, 11, 20,	2N2634 2N2635	HF102
2N2255	2N2253	A22	2N2370	LL35, HF86 A6		HF72	2N2647 2N2649	UJT1, 3 HF102
2N2258	2N2255 2N2256	LL29, HF71	2N2372	A6	2N2511	HF17	2N2654	HF44
2N2267	2N2258 2N2259	LL29, HF71 LL29, HF71	2N2378	HF6	2N2515 2N2516	HF47 HF51	2N2658	P14
Name	2N2267 2N2268	P51 P51	2N2382 2N2383	LL28, HF67 P61	2N2519 2N2520	HF48 HF44	2N2672 2N2673	HF27 A3
2N2275	2N2270	HL17, P16 HF60	2N2386	FET8, 12, 23, 43, 46, 55	2N2522 2N2523	HF51 HF60	2N2675 2N2676	A19 A34
Second Process of Pr	2N2275	LL8	2N2388	A42 A18, HL45,	2N2525 2N2526	P30, HF46 HL46, P62	2N2678 2N2692	LL15 LL43
2N2280 LL14 2N2392 A15 2N2538 LL32, HF61 2N2707 A42 2N2281 LL15 2N2394 HL46 2N2539 LL32, HF61 2N2708 HF86 2N2282 P16 2N2395 HL46, HF101 2N2540 LL32, HF61 2N2709 HF1 2N2283 P16 2N2397 HL19, HF50 2N2551 LL43 2N2711 A16 2N2284 P16 2N2398 HF101 2N2552 P31 2N2712 A33 2N2285 HL44, P77 2N2400 HF44 2N2553 P31 2N2712 A33 2N2286 HL44, P77 2N2400 HF44 2N2554 P32 2N2714 A33 2N2287 HL44, P78 2N2401 HF50 2N2555 P32 2N2715 A36 2N2288 HL44, P55 2N2402 HF60 2N2556 P32 2N2716 A40 2N2289 HL44, P55 2N2405 HF33 2N2557 P32 2N2717	2N2277 2N2278	LL8, HF4 LL10		HL46	2N2528	HL46, P62	2N2698	P33
2N2283 P16 2N2397 HL19, HF50 2N2551 LL43 2N2711 A16 2N2284 P16 2N2398 HF101 2N2552 P31 2N2712 A33 2N2285 HL44, P77 2N2400 HF44 2N2553 P31 2N2713 A17 2N2286 HL44, P77 2N2400 HF44 2N2554 P32 2N2714 A33 2N2287 HL44, P78 2N2401 HF50 2N2555 P32 2N2715 A36 2N2288 HL44, P55 2N2402 HF60 2N2556 P32 2N2715 A40 2N2289 HL44, P55 2N2405 HF33 2N2557 P32 2N2716 A40 2N2289 HL44, P55 2N2405 HF33 2N2557 P32 2N2717 A27, LL28 2N2290 HL44, P56 2N2410 HL46, HF101 2N2558 P32 2N2720 HF29 2N2291 HL45, P56 2N2411 HL46, HF101 2N2559 P32 2N2721 HF29 2N2292 HL45, P56 2N2412 HF101 2N2560 HL2, P32 2N2722 HF33 2N2293 HL45, P56 2N2413 HF101 2N2561 P32 2N2723 HF102	2N2280 2N2281	LL14 LL15	2N2394	HL46	2N2539	LL32, HF61	2N2708	HF86
2N2286 HL44, P77 2N2400 HF44 2N2554 P32 2N2714 A33 2N2287 HL44, P78 2N2401 HF50 2N2555 P32 2N2715 A36 2N2288 HL44, P55 2N2402 HF60 2N2556 P32 2N2716 A40 2N2289 HL44, P55 2N2405 HF33 2N2557 P32 2N2717 A27, LL28 2N2290 HL44, P56 2N2410 HL46, HF101 2N2558 P32 2N2720 HF29 2N2291 HL45, P56 2N2411 HL46, HF101 2N2559 P32 2N2721 HF29 2N2292 HL45, P56 2N2412 HF101 2N2560 HL2, P32 2N2722 HF33 2N2293 HL45, P56 2N2413 HF101 2N2561 P32 2N2723 HF102	2N2283 2N2284	P16 P16	2N2398 2N2399	HF101 HF101	2N2552	P31	2N2711 2N2712	A16 A33
2N2289 HL44, P55 2N2405 HF33 2N2557 P32 2N2717 A27, LL28 2N2290 HL44, P56 2N2410 HL46, HF101 2N2558 P32 2N2720 HF29 2N2291 HL45, P56 2N2411 HL46, HF101 2N2559 P32 2N2721 HF29 2N2292 HL45, P56 2N2412 HF101 2N2560 HL2, P32 2N2722 HF33 2N2293 HL45, P56 2N2413 HF101 2N2561 P32 2N2723 HF102	2N2286 2N2287	HL44, P77 HL44, P78	2N2401	HF50	2N2554 2N2555	P32 P32	2N2714 2N2715	A33 A36
2N2291 HL45, P56 2N2412 HF101 2N2560 HL2, P32 2N2722 HF33 2N2293 HL45, P56 2N2413 HF101 2N2561 P32 2N2723 HF102	2N2289 2N2290	HL44, P55 HL44, P56	2N2405 2N2410	HF33 HL46, HF101	2N2557 2N2558	P32 P32	2N2717 2N2720	A27, LL28 HF29
	2N2292 2N2293	HL45, P56 HL45, P56	2N2412 2N2413	HF101 HF101	2N2560 2N2561	HL2, P32 P32	2N2722 2N2723	HF33 HF102

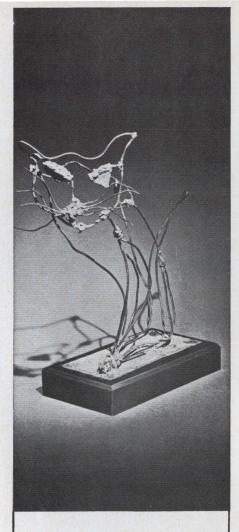
2N2725 2N2726 2N2727 2N2728 2N2729 2N2730 2N2731 2N2733 2N2734 2N2735 2N2736 2N2737 2N2738 2N2740 2N2741 2N2745 2N2745 2N2745 2N2746 2N2747 2N2748 2N2752 2N2753 2N2754 2N2755 2N2756 2N2757 2N2758 2N2759 2N2760 2N2761 2N2763 2N2764 2N2765 2N2765 2N2766 2N2766 2N2767 2N2768 2N2768 2N2769 2N2769 2N2770 2N2771 2N2782 2N2788 2N2788 2N2789 2N2789 2N2789 2N2790 2N2797 2N2798 2N2797 2N2798 2N2799 2N2797 2N2798 2N2799 2N2800 2N2808 2N2808 2N2808	HF102 P17 P17 P95 A24, HF89 P95 P95 P95 P84
2N2791 2N2792 2N2795 2N2796 2N2797 2N2798 2N2799 2N2800 2N2801 2N2801 2N2808	LL35, HF61 HF67 HF67 HF44 HF40 HF40 LL22 LL22 HF90 HF90



2N2824	P102	2N2912	P60	2N3018	P36, HF103 LL12, HF26	2N3147	P92
2N2825 2N2828	P102 P50	2N2913 2N2914	HF47 HF24	2N3019 2N3020	LL12, HF26	2N3149 2N3150	P109 P109
2N2829 2N2831	P50 A13	2N2915 2N2916	HF24 HF24	2N3021 2N3022	P36 P36	2N3151 2N3154	P110 P46
2N2832	P62	2N2917	HF24	2N3023	P36	2N3155	P47
2N2833 2N2834	P62 P62	2N2918 2N2919	HF25 HF25	2N3024 2N3025	P36 P36	2N3156 2N3157	P47 P47
2N2835 2N2836	P30 P45	2N2920 2N2923	HF25 A37	2N3026 2N3043	P36 HF67	2N3158 2N3209	P47 HL40
2N2837	HF40	2N2924	A43	2N3049	HF84	2N3212	P26
2N2838 2N2841	HF40 FET18, 28, 48	2N2925 2N2926	A46 A18	2N3053 2N3054	HL36 HL25	2N3213 2N3214	P26 P26
2N2842 2N2843	FET19, 30, 48 FET19, 33	2N2927 2N2929	HF45 HF91	2N3055	HL23	2N3215 2N3220	P27 P41
2N2844	FET19, 37	2N2936	HF103	2N3056 2N3056A	P18, HF26 P18	2N3221	P41
2N2845 2N2846	HF72 HF72	2N2937 2N2938	HF103 LL44	2N3057 2N3057A	P18, HF26 P18	2N3222 2N3223	P41 P59
2N2847 2N2848	HF72 HF72	2N2942 2N2943	HF45 HF40	2N3058 2N3059	A36 A46	2N3227 2N3229	HL23, HF80 HF53
2N2849	HL34	2N2944	LL12, HF9 LL7, HF4	2N3060	A36	2N3230	P36
2N2850 2N2851	HL31 HL31	2N2945 2N2946	LL7, HF4 LL5, HF2	2N3061 2N3062	A44 A31	2N3231 2N3241	P36 A44
2N2852 2N2853	HL28 HL31	2N2947 2N2948	HF34 HF34	2N3063 2N3064	A31 A21	2N3242 2N3244	A44 HF48
2N2854 2N2855	HL34 HL31	2N2949	HF34	2N3065 2N3066	A21 FET40	2N3245	HF45
2N2856	HL28	2N2950 2N2951	HF34 HF52	2N3067	FET34	2N3248 2N3249	HF62 HF67
2N2857 2N2860	HF91 A14	2N2952 2N2953	HF52 A47	2N3068 2N3069	FET29 FET44	2N3250 2N3250A	LL25, HF62 HL22
2N2861 2N2862	HF103 HF103	2N2955	HF73	2N3070 2N3071	FET38 FET31	2N3251	LL28, HF68
2N2863 2N2864	HF103 HF103	2N2956 2N2957	HF74 HF75	2N3074 2N3075	HF48	2N3251A 2N3252	HL23 HL19, HF53
2N2865	HF103	2N2958 2N2959	HF62 HF62	2N3076	HF26 HL30, P83	2N3253 2N3262	HL18, HF48 HF45
2N2868 2N2869	A20 P40	2N2962 2N2963	HF86 HF86	2N3077 2N3078	A49 A48	2N3263 2N3264	P83 P61
2N2870 2N2871	P40 LL43	2N2964 2N2965	HF87 HF87	2N3081 2N3081/46	HF45 HF45	2N3265	P83
2N2872 2N2874	LL43 P29, HF43	2N2966	HF88	2N3081/51 2N3084		2N3266 2N3277	P61 FET36
2N2875	P33	2N2968 2N2969	LL12 LL12	2N3085	FET40	2N3278 2N3279	FET40 HF76
2N2876 2N2877	HF51 P40	2N2970 2N2971	LL11 LL11	2N3086 2N3087	FET40 FET40	2N3280 2N3281	HF76 HF68
2N2878 2N2879	P40 P40	2N2972	HF25	2N3088 2N3088A	FET52 FET53	2N3282	HF68
2N2880 2N2881	P40 P23	2N2973 2N2974	HF25 HF25	2N3089 2N3089A	FET37, 52 FET37, 53	2N3283 2N3284	HF62 HF63
2N2882	P23	2N2975 2N2976	HF25 HF25	2N3107	LL18	2N3285 2N3286	HF63 HF63
2N2883 2N2884	HF80 HF80	2N2977 2N2978	HF25 HF25	2N3108 2N3109	HL34, LL19 LL18	2N3287 2N3288	HF73 HF73
2N2885 2N2887	HF67 P35, HF67	2N2979	HF26	2N3110 2N3112	HL34, LL19 FET18, 28	2N3289	HF68
2N2890 2N2891	P17 P17	2N2980 2N2981	HF22 HF22	2N3113 2N3114	FET18, 29 P18	2N3290 2N3291	HF68 HF63
2N2892	P40	2N2982 2N2987	HF26 P29	2N3115	HF62	2N3292 2N3293	HF58 HF58
2N2893 2N2894	P40 HF73	2N2988 2N2989	P29 P29	2N3116 2N3117	HF62 HL32	2N3294	HF58
2N2895 2N2896	HF34 HF34	2N2990	P29	2N3118 2N3119	HF62 HF62	2N3295 2N3296	HF2 HF1
2N2897 2N2898	HF34 HF34	2N2991 2N2992	P29 P29	2N3128 2N3129	A32 A42	2N3297 2N3298	HF1 HF53
2N2899	HF34	2N2993 2N2994	P29 P29	2N3130	A38	2N3299 2N3300	HL39, HF76 HL39, HF76
2N2900 2N2902	HF34 P50, 106	2N2995	P29	2N3131 2N3133	LL28 HF52	2N3301	HL39, HF76
2N2903 2N2903A	A41 A41	2N2996 2N2997	HF76 HF76	2N3134 2N3135	HF52 HF52	2N3302 2N3303	HL39, HF76 HL40, HF86
2N2904 2N2904A	HF51	2N2998 2N2999	HF84 HF93	2N3136 2N3137	HF52 HF87	2N3304 2N3307	HF87 HF68
2N2905	HF51	2N3009 2N3010	LL30, HF73 LL34	2N3138 2N3139	HF104 HF104	2N3308 2N3309	HF68 HF68
2N2905A 2N2906	HF52	2N3011	LL32	2N3140	HF104	2N3311	P95
2N2906A 2N2907	HF52 HF52	2N3012 2N3013	LL32 HL24, HF83	2N3141 2N3142	HF104 HF104	2N3312 2N3313	P95 P95
2N2907A 2N2908		2N3014 2N3015	HL24, HF83 LL25, HF62	2N3143 2N3144	HF104 HF104	2N3314 2N3315	P96 P96
2N2909	A21	2N3016	P18, HF103	2N3145	HF104	2N3316	P96
2N2911	P23	2N3017	HF103	2N3146	P92	2N3317	LL9, HF10

2N3318	LL10, HF6
2N3319	LL13, HF10
2N3320	HF84
2N3321	HF84
2N3322	HF84
2N3323	HF53
2N3324	HF53
2N3325	HF53
2N3326	HF58
2N3327	HF76
2N3328	FET42
2N3329 2N3330	FET2, 13, 20, 43, 52 FET2, 13, 21,
2N3331	44, 52 FET3, 12, 22,
2N3331	47, 51
2N3332	FET8, 13, 21,
2N3333	43, 53 FET25
2N3334	FET24
2N3335	FET24
2N3336	FET24
2N3337	HF76
2N3338	HF77
2N3339	HF77
2N3340	LL18
2N3341 2N3342	LL18 LL3 LL3
2N3344 2N3345	LL3
2N3346	LL3
2N3365	FET40
2N3366	FET34
2N3367	FET29
2N3368	FET45
2N3369	FET38
2N3370	FET31
2N3371	HF77
2N3374	P18
2N3375	HF81
2N3376	FET1, 39, 58
2N3377	FET1, 40, 58
2N3378 2N3379	FET1, 40, 58 FET2, 46, 58 FET3, 46, 58 FET4, 58
2N3380 2N3381	FET4, 58
2N3382	FET4
2N3383	FET5
2N3384	FET6
2N3385	FET6
2N3386 2N3387	FET6
2N3390	A48
2N3391	A47
2N3391A	A47
2N3392	A43
2N3393	A37
2N3394	A27
2N3395	A49
2N3396	A49
2N3397	A49
2N3398	A49
2N3399	HF84
2N3402	A33
2N3403	A44
2N3404	A33
2N3405	A44
2N3409	HF59
2N3410	HF59
2N3411	HF59
2N3414	A34
2N3415	A44
2N3416	A34
2N3417	A44
2N3418	P25
2N3419	P25
2N3420	P25





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134

2112121	505	0110546	111.05
2N3421	P25	2N3546	HL25
2N3423	HL40, HF85	2N3551	P50
2N3424	HL25, HF85	2N3552	P51
2N3426	HL19, HF53	2N3553	HF81
	A46	2N3554	LL23
2N3427			
2N3428	A48	2N3563	HF89
2N3429	HL19, P88	2N3564	HF87
2N3430	HL19, P88	2N3565	HF16
2N3431	HL19, P88	2N3566	HF16
2N3432	HL19, P88	2N3567	HF22
2N3433	HL19, P89	2N3568	HF22
2N3434	HL20, P89	2N3569	HF23
THE RESERVE OF THE PARTY OF THE	FET4, 46	2N3570	HF93
2N3436	FET4, 40	The state of the s	
2N3437	FET3, 41	2N3571	HF92
2N3438	FET34	2N3572	HF91
2N3439	P18	2N3576	LL32
	P18	2N3577	P62
2N3440			
2N3441	P37	2N3578	FET42, 50
2N3442	P81	2N3579	A10
2N3444	HL18	2N3580	A21
2N3445	P81	2N3581	A25
	P81		A38
2N3446		2N3582	
2N3447	P81	2N3583	P45
2N3448	P81	2N3584	P45
2N3452	FET41, 52	2N3585	P46
		2N3588	HF57
2N3453	FET34, 52		
2N3454	FET29, 52	2N3597	P78
2N3455	FET41, 51	2N3598	P78
2N3456	FET34, 51	2N3599	P78
2N3457	FET29, 51	2N3600	HF89
	TETA 47 50		
2N3458	FET4, 47, 50	2N3605	LL28
2N3459	FET3, 41, 52	2N3606	LL28
2N3460	FET2, 34, 52	2N3607	LL28
2N3462	A35	2N3608	FET5, 14, 49, 57
2N3463	A35	2N3609	FET25
2N3467	HL18	2N3610	FET1
2N3468	HL17	2N3611	P62
2N3469	P15	2N3612	P62
2N3470		2N3613	P63
		The second secon	
2N3471	HL23, P89	2N3614	P63
2N3472	HL24, P89	2N3615	P63
2N3473	HL24, P89	2N3616	P63
2N3474	HL24, P89	2N3617	P63
2N3475	HL24, P89	2N3618	P63
2N3476	HL24, P89	2N3619	HF53
2N3477	HL24, P89	2N3620	HF54
2N3478	HF89	2N3621	HF53
2N3485	LL23, HL20	2N3622	HF53
2N3485A	LL23, HL20	2N3623	HF54
2N3486	LL23, HL20		
2N3486A		2N3624	HF54
		2N3625	HF54
2N3487	P81	2N3626	HF54
2N3488	P81	2N3627	HF54
2N3489	P82	2N3628	HF54
2N3490	P82	2N3629	HF54
2N3491	P82	2N3630	HF54
2N3492	P82	2N3631	FET4, 13
2N3493	LL32	2N3632	HF77
2N3493 2N3494	HL20		
2N3494	HL20	2N3633	HF92
2N3494 2N3495	HL20 HL17	2N3633 2N3634	HF92 HL18
2N3494 2N3495 2N3496	HL20 HL17 HL20	2N3633 2N3634 2N3635	HF92 HL18 HL20
2N3494 2N3495 2N3496 2N3497	HL20 HL17 HL20 HL17	2N3633 2N3634 2N3635 2N3636	HF92 HL18 HL20 HL18
2N3494 2N3495 2N3496 2N3497 2N3498	HL20 HL17 HL20 HL17 HL17	2N3633 2N3634 2N3635	HF92 HL18 HL20
2N3494 2N3495 2N3496 2N3497 2N3498 2N3499	HL20 HL17 HL20 HL17 HL17 HL17	2N3633 2N3634 2N3635 2N3636	HF92 HL18 HL20 HL18 HL20
2N3494 2N3495 2N3496 2N3497 2N3498	HL20 HL17 HL20 HL17 HL17 HL17	2N3633 2N3634 2N3635 2N3636 2N3637 2N3638	HF92 HL18 HL20 HL18 HL20 HF45
2N3494 2N3495 2N3496 2N3497 2N3498 2N3499 2N3500	HL20 HL17 HL20 HL17 HL17 HL17 HL17	2N3633 2N3634 2N3635 2N3636 2N3637 2N3638 2N3640	HF92 HL18 HL20 HL18 HL20 HF45 LL34
2N3494 2N3495 2N3496 2N3497 2N3498 2N3499 2N3500 2N3501	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL17	2N3633 2N3634 2N3635 2N3636 2N3637 2N3638 2N3640 2N3641	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25
2N3494 2N3495 2N3496 2N3497 2N3498 2N3499 2N3500 2N3501 2N3502	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL17 HL38, HF59	2N3633 2N3634 2N3635 2N3636 2N3637 2N3638 2N3640	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25 LL25
2N3494 2N3495 2N3496 2N3497 2N3498 2N3500 2N3500 2N3501 2N3502 2N3503	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL17 HL38, HF59 HL38, HF63	2N3633 2N3634 2N3635 2N3636 2N3637 2N3638 2N3640 2N3641 2N3642	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25 LL25
2N3494 2N3495 2N3496 2N3497 2N3498 2N3499 2N3500 2N3501 2N3502	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL17 HL38, HF59 HL38, HF63	2N3633 2N3634 2N3635 2N3636 2N3637 2N3638 2N3640 2N3641 2N3642 2N3643	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25 LL25
2N3494 2N3495 2N3496 2N3497 2N3498 2N3500 2N3501 2N3502 2N3503 2N3504	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL38, HF59 HL38, HF63 HL22, HF63	2N3633 2N3634 2N3635 2N3636 2N3637 2N3640 2N3641 2N3642 2N3643 2N3644	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25 LL25 LL25
2N3494 2N3495 2N3496 2N3497 2N3498 2N3500 2N3500 2N3501 2N3502 2N3503 2N3504 2N3505	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL17 HL38, HF59 HL38, HF63 HL22, HF63 HL38, HF63	2N3633 2N3634 2N3635 2N3636 2N3637 2N3638 2N3640 2N3641 2N3642 2N3643 2N3644 2N3645	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25 LL25 LL25 LL25
2N3494 2N3495 2N3496 2N3497 2N3498 2N3500 2N3500 2N3501 2N3502 2N3503 2N3504 2N3505 2N3506	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL17 HL38, HF59 HL38, HF63 HL22, HF63 HL22, HF63 HL17	2N3633 2N3634 2N3635 2N3636 2N3637 2N3640 2N3641 2N3642 2N3643 2N3644 2N3645 2N3646	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25 LL25 LL25 LL24 LL24
2N3494 2N3495 2N3496 2N3497 2N3498 2N3500 2N3500 2N3501 2N3503 2N3503 2N3504 2N3505 2N3506 2N3507	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL17 HL38, HF59 HL38, HF63 HL22, HF63 HL22, HF63 HL17 HL17	2N3633 2N3634 2N3635 2N3636 2N3637 2N3640 2N3641 2N3642 2N3643 2N3644 2N3645 2N3646 2N3647	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25 LL25 LL25 LL25 LL24 LL24 LL34 HL34
2N3494 2N3495 2N3496 2N3497 2N3498 2N3500 2N3500 2N3501 2N3502 2N3503 2N3504 2N3505 2N3506	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL17 HL38, HF59 HL38, HF63 HL22, HF63 HL17 HL17 HL17	2N3633 2N3634 2N3635 2N3636 2N3637 2N3640 2N3641 2N3642 2N3643 2N3644 2N3645 2N3646	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25 LL25 LL25 LL24 LL24
2N3494 2N3495 2N3496 2N3497 2N3498 2N3500 2N3500 2N3501 2N3502 2N3503 2N3504 2N3505 2N3506 2N3507 2N3508	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL17 HL38, HF59 HL38, HF63 HL22, HF63 HL17 HL17 HL17	2N3633 2N3634 2N3635 2N3636 2N3637 2N3638 2N3641 2N3642 2N3644 2N3645 2N3645 2N3645 2N3646 2N3647 2N3648	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25 LL25 LL25 LL25 LL24 LL24 LL24 LL34 HL23, LL30 HL23, LL30
2N3494 2N3495 2N3496 2N3497 2N3498 2N3499 2N3500 2N3501 2N3502 2N3503 2N3504 2N3505 2N3506 2N3507 2N3508 2N3509	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL17 HL38, HF59 HL38, HF63 HL22, HF63 HL22, HF63 HL17 HL17 HL17	2N3633 2N3634 2N3635 2N3636 2N3637 2N3638 2N3640 2N3641 2N3642 2N3643 2N3644 2N3645 2N3645 2N3646 2N3647 2N3648 2N3660	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25 LL25 LL25 LL24 LL24 LL24 LL34 HL23, LL30 HL23, LL33 P18
2N3494 2N3495 2N3496 2N3497 2N3498 2N3500 2N3501 2N3502 2N3503 2N3504 2N3505 2N3506 2N3507 2N3508 2N3509 2N3509	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL17 HL38, HF59 HL38, HF63 HL22, HF63 HL22, HF63 HL17 HL17 HL17 HL17	2N3633 2N3634 2N3635 2N3636 2N3637 2N3648 2N3644 2N3644 2N3645 2N3645 2N3646 2N3648 2N3660 2N3661	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25 LL25 LL25 LL24 LL24 LL34 HL23, LL30 HL23, LL33 P18 P19
2N3494 2N3495 2N3496 2N3497 2N3498 2N3500 2N3501 2N3502 2N3503 2N3504 2N3505 2N3506 2N3507 2N3508 2N3509 2N3510	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL17 HL38, HF59 HL38, HF63 HL22, HF63 HL17 HL17 HL17 HL17 HL17	2N3633 2N3634 2N3635 2N3636 2N3638 2N3640 2N3641 2N3642 2N3644 2N3645 2N3646 2N3647 2N3660 2N3661 2N3661	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25 LL25 LL25 LL24 LL24 LL24 LL34 HL23, LL30 HL23, LL30 HL23, LL30 HL99 HF90
2N3494 2N3495 2N3496 2N3497 2N3498 2N3500 2N3501 2N3502 2N3503 2N3504 2N3505 2N3506 2N3507 2N3508 2N3509 2N3509	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL17 HL38, HF59 HL38, HF63 HL22, HF63 HL22, HF63 HL17 HL17 HL17 HL17	2N3633 2N3634 2N3635 2N3636 2N3637 2N3648 2N3644 2N3644 2N3645 2N3645 2N3646 2N3648 2N3660 2N3661	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25 LL25 LL25 LL24 LL24 LL24 LL34 HL23, LL30 HL23, LL33 P18 P19 HF90 HF90
2N3494 2N3495 2N3496 2N3497 2N3498 2N3500 2N3501 2N3502 2N3503 2N3504 2N3505 2N3506 2N3507 2N3508 2N3509 2N3510	HL20 HL17 HL20 HL17 HL17 HL17 HL17 HL17 HL38, HF59 HL38, HF63 HL22, HF63 HL17 HL17 HL17 HL17 HL17	2N3633 2N3634 2N3635 2N3636 2N3638 2N3640 2N3641 2N3642 2N3644 2N3645 2N3646 2N3647 2N3660 2N3661 2N3661	HF92 HL18 HL20 HL18 HL20 HF45 LL34 LL25 LL25 LL25 LL24 LL24 LL24 LL34 HL23, LL30 HL23, LL30 HL23, LL30 HL99 HF90

2N3666 2N3677 2N3683 2N3684 2N3685 2N3686 2N3688 2N3689 2N3690 2N3691 2N3692 2N3693 2N3694 2N3694 2N3697 2N3697 2N3698 2N3699 2N3699 2N3701 2N3702 2N3703	P19 LL7, 14 HF85 FET46, 54 FET43, 54 FET31, 54 HF77 HF77 A23, HF54 A40, HF55 HF55 HF55 FET43, 54 FET37, 54 FET37, 54 FET33, 54 FET29, 54 P19 HF55 HF35
2N3704 2N3705 2N3706 2N3707 2N3708 2N3709 2N3710 2N3711 2N3712 2N3713 2N3714 2N3715 2N3716 2N3719 2N3720 2N3721 2N3722 2N3723 2N3722 2N3723 2N3728 2N3729 2N3730	HF35 HF35 HF35 A40 A23 A23 A37 A45 HF16 HL27, P90 HL27, P90 HL27, P90 HL27, P91 HL32, P21 A30 LL32 LL32 HF77 HF77 P25
2N3731 2N3732 2N3733 2N3734 2N3735 2N3736 2N3737 2N3738 2N3740 2N3740 2N3741 2N3742 2N3742 2N3744 2N3745 2N3745 2N3746 2N3747	P19 P13 HF78 HL22, HF63 HL22, HF64 HL22, HF64 HL27, P33 HL28, P33 HL27, P37 HL27, P37 HF14 HF14 P41 P41 P41 P41
2N3749 2N3750 2N3751 2N3752 2N3762 2N3763 2N3764 2N3765 2N3766 HL 2N3767 2N3771 2N3772 2N3773 2N3783 2N3783 2N3784 2N3785 2N3789	P41 P41 P42 P42 HL37, HF49 HL37, HF45 HL37, HF45 28, P33, HF55 HL28, P33 P90 P90 P90 HF88 HF88 HF88 P90



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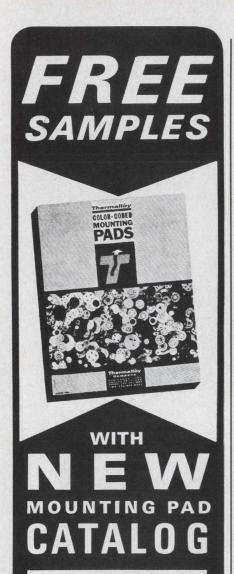
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2N3790	P90	2N3919	HL34, P30	2N4050	P96
		2N3920	HL34, P30	2N4051	P96
2N3791	P90				
2N3792	P91	2N3921	FET26	2N4052	P96
2N3796	FET9, 20, 39, 50	2N3922	FET26	2N4053	P96
2N3797	FET9, 21, 47, 50	2N3924	HF81	2N4058	LL44
	1119, 21, 47, 30	2N3925	HF81	THE RESERVE OF THE PARTY OF THE	LL44
2N3798	HF35		HF81	2N4059	
2N3799	HF35	2N3926		2N4060	LL44
2N3800	HF35	2N3927	HF81	2N4061	LL44
2N3801	HF35	2N3932	HF93	2N4062	LL44
			HF93	THE RESERVE OF THE PROPERTY OF THE PARTY OF	
2N3802	HF35	2N3933		2N4065	FET16
2N3803	HF36	2N3934	FET26	2N4066	FET14
2N3804	HF36	2N3935	FET25	2N4067	FET14
2N3805	HF36	2N3946	LL26, HF64	2N4070	P58
		2N3947	LL28, HF69		A P SPICE SHALL WHEN WE WANTED
2N3806	HF36		HF92	2N4071	P59
2N3807	HF36	2N3953		2N4072	HF83
2N3808	HF36	2N3954	FET26	2N4073	HF83
2N3809	HF36	2N3955	FET26	2N4075	P43
2N3810	HF36	2N3956	FET25	2N4076	P43
		2N3957	FET25		
2N3811	HF36	2N3958	FET25	2N4077	P22
2N3818	HF46			2N4078	P22
2N3819	FET9, 12, 21,	2N3959	LL36, HF93	2N4079	P110
2110013	45, 55, 59	2N3960	LL36, HF93	2N4082	FET27
0110000		2N3961	HF81	Charles In the Control of the Contro	
2N3820	FET9, 12, 19,	2N3960	LL37, HF93	2N4083	FET26
	36, 55, 58		HF46	2N8084	FET27
2N3821	FET9, 14, 20,	2N3962		2N4085	FET26
	38, 42, 51, 59	2N3963	HF46	2N4086	A43
2N3822	FET9, 21, 39,	2N3964	HF46	2N4087	A47
2142022		2N3965	HF46		
	45, 51, 59	2N3966	FET5	2N4087A	A47
2N3823	FET9, 12, 21,			2N4091	FET8
	43, 52, 53, 59	2N3967	FET22	2N4092	FET7
2N3824	FET5, 12, 16	2N3968	FET20	2N4093	FET7
2N3837	P37	2N3969	FET20	2N4104	HF29
	P37	2N3970	FET11		
2N3838		THE PARTY OF THE P		2N4105	P6
2N3840	LL8	2N3971	FET7, 13, 15	2N4106	P6
2N3841	LL4	2N3972	FET6, 15	2N4107	P111
2N3842	LL4	2N3973	LL30	2N4117	FET28
	HF42	2N3974	LL30		
2N3843		2N3975	LL30	2N4118	FET30
2N3843A			LL30	2N4119	FET33
2N3844	HF42	2N3976		2N4120	FET16
2N3844A	HF42	2N3977	LL4	2N4121	LL34
2N3845	HF42	2N3978	LL4	2N4122	LL34
		2N3979	LL4		
2N3845A			UJT2, 3	2N4123	LL26, HF64
2N3846	P91	2N3980	0312,3	2N4124	LL28, HF69
2N3847	P91	2N3993	FET6, 13	2N4125	LL24, HF55
2N3848	P91	2N3994	FET5, 15, 21	2N4126	LL26, HF64
2N3849	P91	2N3995	HF85	2N4136	P111
		2N3996	P42		
2N3850	HL16, P42	2N3997	P42	2N4138	HF12
2N3851	P42, 51		P42	2N4220	FET9, 16, 20,
2N3852	HL16, P42	2N3998			39, 51
2N3853	P42	2N3999	P42	2N4221	FET9, 16, 21,
2N3854	HF68	2N4000	P30		44, 51
		2N4001	P30	2014222	FET10, 16, 22,
2N3854A		2N4001 2N4002	P78	2N4222	
2N3855	HF73				47, 51
2N3855A		2N4003	P78	2N4223	FET51, 59
2N3856	HF74	2N4004	P50	2N4224	FET59
2N3856A	HF74	2N4005	P50	2N4241	P47
2N3858	A29	2N4012	HF81	2N4260	LL36, HF93
		2N4017	A47		LL36, HF94
2N3858A		2N4017 2N4018	A48	2N4261	1130, 1150
2N3859	A39			2N4264	LL29, HF69
2N3959A	A39	2N4019	A48	2N4265	LL29, HF69
2N3860	A43	2N4020	A50	2N4267	FET14
2N3866	HF88	2N4021	A50	2N4268	FET14
	A11	2N4022	A50	3N45	P60
2N3877		A STATISTICAL STATISTICS OF THE STATIST OF		3N46	P60
2N3877A		2N4023	A50		
2N3878	P46	2N4024	A50	3N47	P60
2N3879	HL32	2N4025	A50	3N48	P60
2N3880	HF92	2N4030	A22	3N49	P77
	LL20	2N4031	A22	3N50	P77
2N3883		The second second second second second	A40		P77
2N3900	A47	2N4032		3N51	
2N3900A		2N4033	A40	3N52	P77
2N3903	LL26, HF64	2N4038	FET59	3N71	LL20
2N3904	LL28, HF69	2N4039	FET59	3N72	LL20
	LL24, HF64		P30	3N73	LL20
2N3905		2N4040			FET38, 57
2N3906	LL26, HF69	2N4041	P26	3N89	
2N3909	FET9, 16, 19,	2N4046	LL33	3N90	HF4
	36, 55	2N4047	LL33	3N91	HF4
		The second secon		3N92	HF4
2N3016		2N4048	P96	SINGL	111 4
2N3916 2N3917	P19 P33	2N4048 2N4049	P96 P96	3N93	HF4

3N94 3N95 3N96 3N97 FET26 3N97 FET25 3N98 FET22 3N112 HF5 3N113 HF5 3N113 HF5 3N114 HF10 3N115 HF10 3N116 HF11 3N117 HF11 3N118 HF11 3N123 SN124 FET10, 16, 19, 35 3N125 FET10, 16, 21, 43 3N126 FET10, 16, 21, 43 3N126 FET10, 16, 22, 46 151-04 HL12, P78 151-05 HL12, P78 151-06 HL12, P78 151-07 HL12, P78 151-08 HL12, P79 151-10 HL12, P79 151-10 HL12, P79 151-12 P79 151-14 P79 151-15 P78 151-20 P79 151-14 P79 151-16 P79 151-18 P79 151-20 P79 152-06 HL12, P80 152-07 P80 152-08 HL12, P80 152-09 HL12, P80 152-10 HL14, P103 153-16 HL14, P103 154-12 HL14, P103 154-12 HL14, P103 154-12 HL14, P103 154-12 HL15, P104 HL15, P104 HL15, P104 HL15, P104 HL15, P104 HL15, P82 HL15, P82 HL19, P104 HC3-18 HL10, P105 HC3-18 HL10, P105 HC3-18 HL10, P105	164-14 164-16 164-18 164-20 2013 3217 2318 3219 40022 40050 40051 40080 40081 40082 40084 40217 40218 40219 40220 40221 40233 40234 40235 40236 40237 40238 40237 40238 40240 40242 40243 40245 40246 40250 40250 40250 40250 40250 40250 40250 40250 40250 40255 40266 40261 40262 40263 40264 40279 40280 40291 40292 40305 40307 40309 40311 40312 40313 40314 40315 40316 40317 40318 40319 40322 40323 40324 40325 40326	HL11, P105 HL11, P105 HL11, P105 HL11, P106 LL44 LL44 LL44 LL44 LL44 LL44 HF105 HF105 HF105 HF105 HF105 HF90 HF90 HF905 HF105 HF20	40340 40341 40346 40347 40348 40355 40360 40361 40362 40363 40364 40366 40367 40368 40369 40375 40404 40405 A130 A301 A301 A306 A307 A310 A311 A415 A466 A467 A472 A473 A490 A520/A521 A569 A570 A1109 A1170 A1220 A1243 A1341 A1519 AC121 AC163 AC172 AF106 AF109 AF139 AFY34 AFY39 BC107 BCY31 BCY32 BCY31 BCY32 BCY31 BCY32 BCY33 BCY34 BCY38 BCY39 BCY40 BCZ10 BCZ11 BCZ12 BCZ13 BCZ13 BCZ13 BCZ14 BCZ13 BCZ14 BCZ10 BCZ11 BCZ12 BCZ13 BCZ13 BCZ13 BCZ14 BCZ10 BCZ11 BCZ12 BCZ13 BCZ13 BCZ14 BCZ10 BCZ11 BCZ12 BCZ13 BCZ14 BCZ10 BCZ11 BCZ12 BCZ13 BCZ13 BCZ14 BCZ10 BCZ11 BCZ12 BCZ13 BCZ14 BCZ10 BCZ11 BCZ12 BCZ13 BCZ13 BCZ14 BCZ14 BCZ16 BCZ16 BCZ16 BCZ16 BCZ16 BCZ17 BCZ17 BCZ17 BCZ18 BCZ18 BCZ18 BCZ18 BCZ18 BCZ18 BCZ19 BCZ19 BCZ19 BCZ19 BCZ10 BCZ11 BCZ11 BCZ12 BCZ13 BCZ14 BCZ16 BCZ16 BCZ16 BCZ16 BCZ16 BCZ17 BCZ17 BCZ17 BCZ18	HF40 HF41 LL12 P20 HF37 P81 P21 P21 P21 P37 P60 P21 HF87 HF89 A11 HF46 A21 A38 HF483 HF63 HF63 HF83 HF83 HF83 HF83 HF83 HF84 HF85 A25 HF85 HF82 HF85 HF82 HF85 HF82 HF85 HF82 HF82 HF82 HF82 HF82 HF82 HF82 HF82
163-20 HL10, P105	40324	P39	BFY34	P10

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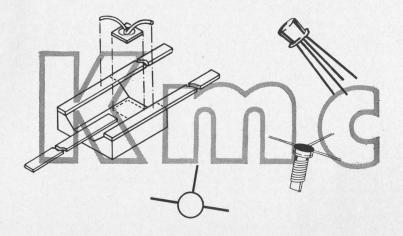
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NS1111 NS1355 NS1356 NS1500 NS1510 OC22 OC23 OC24 OC26 OC30 OC445 OC59 OC60 OC71N OC75N OC79 OC80 P102 P1003 P1004 P1005 PA1101 PADT50 PA1101 PADT50 PA15657 S15657 S15658 S15659 S15650 S15657 S15658 S15659 S15650 S15657 S15658 S15659 S15659 S15659 S15650 S15657 S15658 S15659	LL27 HF37 LL27 HL25 HL25 HL26 P21 HF12 A329 A33 A23 HL25 FET40 FET45 FET48 A26 HF16 LL45 HF87 HF87 HF87 HF87 HF88 HF10 HF10 HF78 HF88 HF10 HF10 HF10 HF10 HF10 HF10 HF10 HF10
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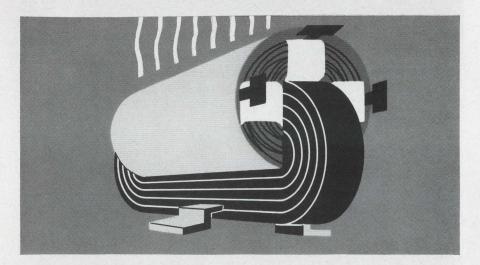
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TIX3016A TIX3024 TIXM101 TIXM103 TIXM104 TIXS09 TIXS10 TIXS11 TIXS33 TIXS35	HF106 HF93 HF93 HF94 HF93 HF105 FET2, 15, 23, 49, 56, 57 FET7, 12 FET10, 15, 22,
TIXS36	48, 56, 60 FET8, 14, 22,
TIXS41 TIXS42 TN53 TN54 TN55 TN56 TN57 TN58 TN59 TN60 TN61 TN62 TN63 TN64 TN79 TN80 TN81 TN237 TN237 TN237 TN238 TW135 U89 U110 U112 U114 U133 U139 U139 U146 U147 U148 U149 U168 U182	48, 56, 60 FET8, 12 FET7, 12 HF38 HF38 HF14 HF14 HF14 HF14 HF138 HF38 HF38 HF38 LL17 LL17 LL17 HF56 HF38 HF38 LL12 FET39, 57 FET32 FET42 FET31 FET66 FET66 FET64 FET67 FET67 FET68 FET49 FET49 FET49, 50 FET49, 50 FET49
FLECTE	ONIC DESIGN

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SU2081

T404

TI156

TI158

FET26

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LL5

P38

P38

U183 U1277 U1278 U1279 U1280 U1281 U1282 U1283 U1284 U1285 U1286 U1287 U1325 UC20 UC21 UC22 UC23 UC40 UC41 UC42 UC43 UC200 UC210 UC210 UC201 UC210 UC250 UC210 UC250 UC210 UC250 UC210 UC250 UC251 UC400 UC450 UC705 UC707 UC701 UC705 UC705 UC705 UC707 UC714 UC750 UC751 UC855 UC853 UC855 UD1000 UD1001 UD1002 UD1003 UD1000 UD3005 UD3006 UD3007 V120 V1	FET46 FET43 FET39 FET35 FET32 FET48 FET47 FET44 FET36 FET37 FET47 FET5 FET44 FET39 FET46 FET32 FET33 FET35 FET30 FET31 FET36 FET42 FET30 FET31 FET36 FET42 FET30 FET31 FET36 FET42 FET31 FET31 FET31 FET31 FET32 FET32 FET32 FET33 FET33 FET33 FET33 FET33 FET33 FET33 FET36 FET42 FET31 FET31 FET32 FET32 FET42 FET33 FET342 FET342 FET36 FET42 FET36 FET42 FET38 FET37 LL16 LL8 LL8 LL8 LL9 LL45 LL45 LL45 LL45 LL45 LL45 LL45
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V221	LL45
V222	LL45
V600	P23
V601	P23



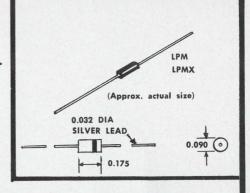
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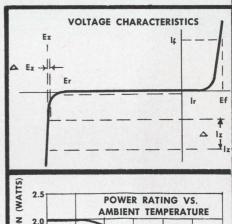


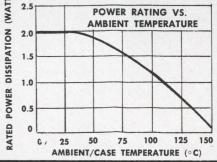
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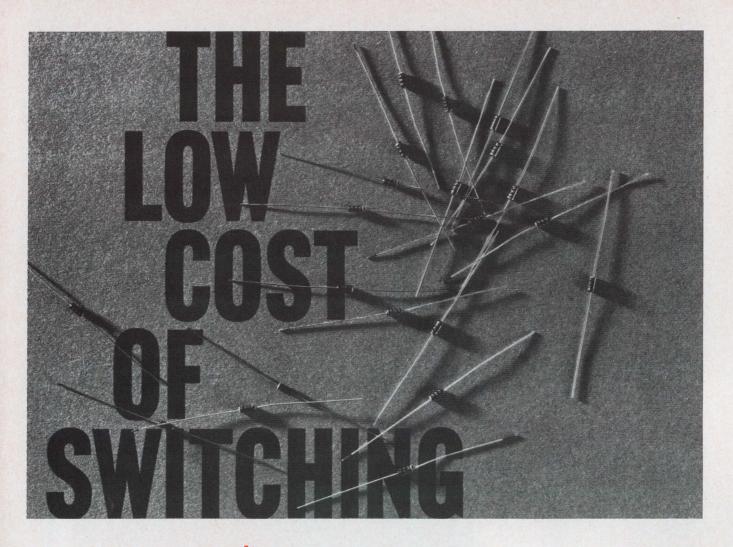
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Leakage Current	Lifetime	Price	
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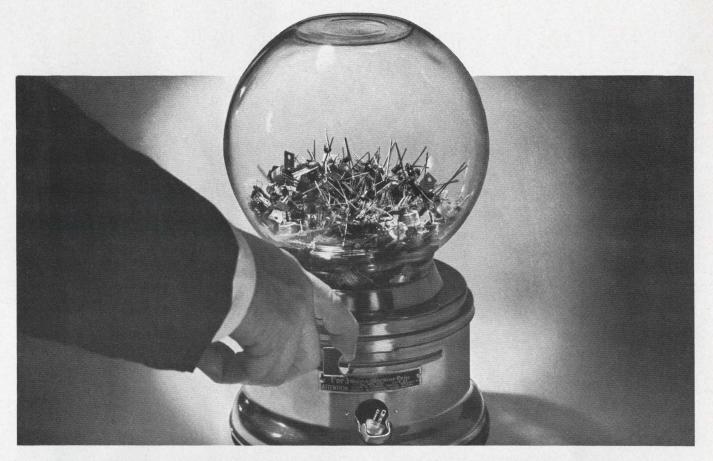
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ELECTRONIC DESIGN

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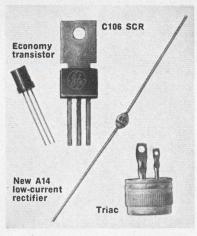
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GENERAL ELECTRIC

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Selecting a thyristor to fill a control need doesn't have to be a difficult choice. These guidelines to the why, where and how of applications simplify the job.

When it comes to switching power or controlling phase, think thyristor. No other family of semiconductor devices offers such a wide choice of suitable designs with comparable efficiency, reliability, flexibility and simplicity.

In most cases the differences between thyristors and other semiconductor types is clear-cut. However, many users are not nearly as confident when it comes to selecting from among thyristors alone. At first glance, there appears to be some overlap in the differing thyristor roles. For example, one might ask, "Where does the SCR end and the Triac begin?"

The answer to this and similar questions lies in a detailed examination of the thyristor family tree:

- The silicon-controlled rectifier (SCR).
- The silicon-controlled switch (SCS).
- The gate-turn-off switch (GTO).
- The four-layer (Shockley) diode, the silicon-unilateral switch (SUS) and the silicon-bilateral switch (SBS).
 - The light-activated SCR (LASCR).
 - The three-element, static, ac switch (Triac).

In each case let us consider first the salient characteristics of the device, then its governing design parameters, and, finally, the major application areas for which each has been tailored.

Understanding and using SCR parameters

The SCR is a regenerative device of pnpn construction with three external connections. To get the most out of this unit and to be able to select the best SCR for an application, one must have a good working knowledge of the basic parameters. The maximum allowable ratings of thyristors are listed on manufacturers' specification sheets, so the designer sees at a glance the one or two devices that are within his specifications. Here are the definitions of the maximum allowable ratings that are usually encountered on the specification sheets:

- *PFV*—The peak forward voltage rating is the maximum allowable instantaneous value of forward voltage that may be applied between anode and cathode without risking damage to the device if switching to the ON state occurs.
 - V_{FXM} —The peak forward blocking voltage

rating is the maximum allowable instantaneous value of forward blocking voltage, including transient voltages, which will not switch the SCR to the ON state. This specification usually states a definite impedance between gate terminal and cathode, or a specific bias voltage.

- $V_{ROM(rep)}$ —The repetitive peak reverse voltage rating (with the gate open) is the maximum allowable instantaneous value of reverse voltage, including all repetitive transient voltages—but excluding all nonrepetitive transient voltages—that may occur across the SCR.
- $V_{ROM(non-rep)}$ —The nonrepetitive peak reverse voltage rating (with the gate open) is the maximum allowable instantaneous value of reverse voltage, including all nonrepetitive transient voltages—but excluding all repetitive transient voltages—that may be applied across the SCR. This rating is slightly higher than $V_{ROM(rep)}$ for each specific voltage rating of an SCR type.



Narrow down thyristor selection problems. Optimize and simplify your power and control designs by using Author Brookmire's guide to distinguishing between members of the thyristor family.

James L. Brookmire, Applications Engineer, General Electric Semiconductor Products Dept., Auburn, N. Y.

• V_{GT} —The gate trigger voltage rating is the dc voltage between the gate and the cathode required to produce the dc gate trigger current.

• I_F rms—The rms forward current is the maximum steady-state rms current that the device is rated for. The rms or effective value in this specification is independent of waveform.

 \bullet $I_{F(AV)}$ —The maximum average forward current depends upon the conduction angle and is usually given in chart form. The chart shows maximum allowable case temperature vs average current for either dc or various conduction angles of a sinusoidal waveform.

■ $I_{FM(surge)}$ —The peak one-cycle surge forward current, nonrepetitive, is the maximum allowable peak current through the collector junction for a positive anode to cathode voltage. This specification is for a single, forward, half cycle (8.3 ms) in a 60-Hz resistive load system. The surge may be preceded and followed by maximum reverse rated voltage, current and junction temperature conditions, and maximum allowable gate power may be concurrently dissipated. However, limitations on anode current during switching should not be exceeded.

■ I_{HX} —The holding current is the minimum current through the collector junction required to maintain the SCR in the ON state for specified conditions and load. The gate terminal is tied to the cathode through an impedance or bias voltage.

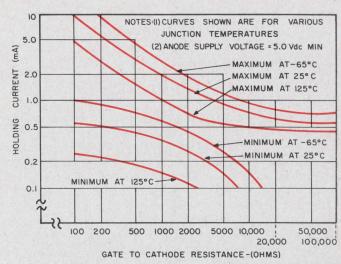
■ I_{GT} —The dc gate trigger current is the minimum dc gate current required to cause switching from OFF to ON for a specified anodeto-cathode voltage, junction temperature and gate impedance. This is one of the most important specifications, for one should always design for the maximum gate current required to fire the particular device, unless selected units are desired.

■ I^2t —This is the maximum allowable forward nonrecurring overcurrent capability for pulse durations greater than a specified time (usually given in milliseconds). Unit I is the rms amperes, and t is the pulse duration in seconds. This specification is for applicable fusing of the device used.

■ t_{off} —The circuit-commutated turn-off time is the interval between the time when the forward current decreases to zero and the device voltage reaches zero and is rising to a stated value of forward blocking voltage (at a stated rate of rise without turning on during switching). This is usually stated for specific conditions of junction temperature, gate impedance, etc.

Don't underestimate rate of rise

Two other SCR specifications that are very important in device selection are dv/dt and di/dt. Dv/dt is the rate of change of voltage, with respect to time, that is applied to the anode-cathode junction. Note that any pn junction has capacitance, and the larger the junction area the higher this capacitance. It follows then that the charging current to this capacitance is equal to $C \, dv/dt$. If a step function of voltage (line transient) is impressed across the anode to cathode of the thyris-



1. Holding current is what keeps an SCR in the conducting state. It is a function of gate-to-cathode resistance and temperature, and is a critical parameter in low-power systems and switching circuits.

tor, the device may inadvertently switch on, due to the triggering action of this charging current.

The definition of the rate of rise of the anode voltage (dv/dt) is the slope of a straight line starting at zero anode voltage and extending through the one-time constant point on an exponentially rising anode voltage. Methods used to increase the SCR's dv/dt capability are: select a higher voltage unit for the application; reverse-bias the gate with respect to the cathode, or provide a series-RC network across the anode-cathode junction to slow the rate of rise of the anode voltage transient.

Di/dt is the rate of rise of the anode current with respect to time. In some cases where di/dt is faster than the time required for the junctions to reach a state of full forward conduction (at uniform current density), localized hot-spot heating will occur in the junction region that has begun to conduct. This may cause excessive temperature rise and subsequent device failure.

Several methods may be utilized to reduce the harmful effect of di/dt.² To cite a few: seriessaturable reactors that limit the rise of current during the initial period of turn-on; small resistances placed in series with the anode-cathode, and combinations of these two remedies.

Other parameters, such as storage temperature, delay times, leakage currents, turn-on times and other voltage ratings, are generally less important in most applications. Moreover the specification sheets usually contain several charts that refer to these factors and to the instantaneous voltagecurrent relationships, power dissipation vs conduction angles, maximum allowable ambient temperature vs average forward current for rectangular waveshapes, and gate trigger current vs gate pulse width, among others. These charts or graphs are usually self-explanatory and give insight into how the device will perform in (specific) applications. An example of such a graph is one showing holding current vs gate-to-cathode impedance for the C5 SCR (Fig. 1). This characteristic is especially important in low-power control logic and switching applications.

A model of SCR behavior

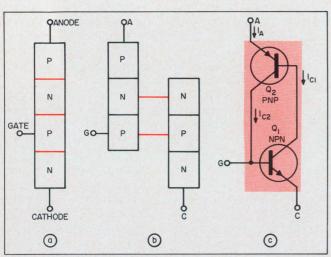
To obtain a basic understanding of how an SCR works, one may analyze its equivalent circuit. Since the SCR and all other thyristors are pnpn structures, a two-transistor analog may be used (Fig. 2).³ Figure 2a (from left to right) shows the four-layer structure with the three external connections. Figure 2b displays the two complementary transistors tied in such a way that collectors and bases of like material, either p or n, form a regenerative feedback connection. The complete transistor analog appears in Fig. 2c.

The total anode to cathode current, I_A , equals the sum of I_{c_1} and I_{c_2} . It is expressed as

$$I_{A} = \frac{(1 + h_{FE_{1}}) (1 + h_{FE_{2}}) (I_{CO_{1}} + I_{CO_{2}})}{1 - (h_{FE_{1}} h_{FE_{2}})}.$$
 (1)

With proper bias applied to the transistor pair (positive anode to cathode voltage), h_{FE1} and h_{FE2} are both low, and their product is much less than unity. This condition exists because the only currents involved are the leakage currents, which are innately small. And because h_{FE} is directly proportional to the collector current, these current gains are also small. Thus the equation develops a value of I_A that is only slightly higher than the sum of I_{CO1} and I_{CO2} . This mode of operation in a pnpn structure is referred to as the forward blocking state, or the OFF condition.

Now, if the product of h_{FE1} and h_{FE2} is made to approach unity, the numerator of Eq. 1 approaches infinity and rapid regeneration takes place. Here the current builds up and drives both transistors to their saturated states, causing the thyristor to unblock or turn ON. The anode-to-cathode voltage becomes low and is the total drop of the three junctions indicated in Fig. 2a.



2. The SCR is a pnpn structure with three external connections (a). It may be represented by two interconnected complementary transistors (b). The complete 2-transistor analogy (c) shows current flow and the regenerative feedback connection.

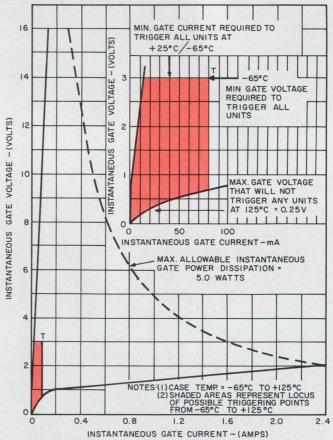
This condition of regeneration may be made to occur by increasing the temperature of the pnpn junction in such a way that the leakage currents become high enough to provide switching action by themselves. Another method is to increase the anode-to-cathode voltage, which again increases the leakage currents. The technique mainly used in the SCR is to provide a positive gate-to-cathode voltage (external base current to Q_1), which causes an unblocking state to be reached by transistor action.

It is interesting to note that in some SCR specifications a maximum impedance to be applied between gate and cathode is usually specified. This is to insure that the SCR will block under a specific junction temperature and for a given forward voltage between anode and cathode. This impedance is necessary to divert part of I_{c2} (mostly leakage current) away from the base of Q_1 , so that regeneration will not occur during the blocking mode.

Charting the application course

Let us now see how to use the parameter data given on specification sheets. We may consider the SCR as a two-circuit link—the gate section (input) and the anode portion (output). Note that the cathode is common to both.

Figure 3 shows the gate-triggering characteris-



3. **Gate triggering characteristics** for a typical SCR (type C35). Note that a locus of firing points exists. Observe that temperature, a major factor on the triggering requirements, should be accounted for in the design.

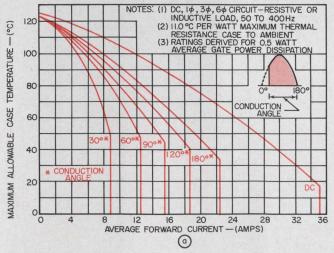
tic of the C35 SCR family. The equivalent circuit between the SCR's gate and cathode terminals consists of a low-voltage pn junction with some series resistance. Thus the gate characteristics may be considered to be those of a modified silicon

pn junction.

The small shaded area in Fig. 3 is enlarged in the upper portion of the graph. This area represents the locus of all points where triggering of all types of SCRs in the C35 family (C35U through C35N) will occur over the junction temperature range of -65°C to +125°C. The boundaries of the locus are also shown for operation over lesser temperature ranges. For example, note that a minimum gate current of 40 mA is required at 25°C to fire all units, whereas at -65°C, 85 mA is needed. A minimum gate signal of three volts is required for reliable triggering at both temperatures. It is imperative that the circuit designer stay out of "shaded areas" to guarantee that 100 percent of the units will trigger. It is recommended that the trigger point be slightly above and to the right of the top-right corner of the shaded area (point T).

The preferred trigger area is bounded by the dotted peak-power dissipation curve and the outer limits of the shaded area. When operating with dc trigger signals, be sure that the steady average gate power dissipation rating isn't exceeded.

The load line of the trigger source should pass through the preferred area of the gate characteristic graph so that the triggering signal is as close as possible to either the average power dissipation (for dc triggering) or to the peak power dissipation (for pulsed cases). The rise time of the trigger signal's leading edge should also be as fast as possible. Fast-rising, high-amplitude gate signals reduce anode switching time and minimize switching dissipation and jitter. This is especially desirable when switching into high anode currents. When the gate is driven with some intermediate type of waveform, such as a rectangular pulse, the



4. Maximum allowable case temperature for sinusoidal currents is a function of conduction angle. Note that the current decreases (for a given case temperature) as the conduction angle decreases. This is because the ratio of rms to average current increases as the conduction angle

average gate power is determined by computing the duty cycle and multiplying it by the peak power value of the pulse. The product should be less than the rated average gate power dissipation of the SCR.

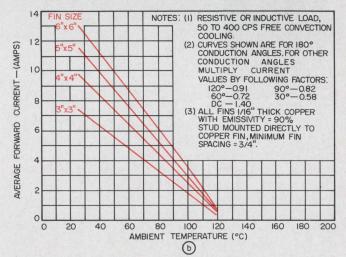
The gate source is established by the opencircuit, gate-source voltage at zero current and the shorted circuit current that is produced by the source voltage, divided by the source impedance.

One may easily visualize what actually occurs during a pulsed-gate triggered condition. The E—I dynamic curve before triggering starts at the origin of the graph and sweeps out to intersect the trigger source load line. At some lesser value of current than that given by the intersection of these two curves, the SCR triggers.

The case for dc over rms

For another example of how to use the specification sheet in designing with SCRs, refer to Fig. 4a. This graph shows the maximum allowable case temperature vs average forward current for different current conduction angles for a sinusoidal voltage waveform applied between the anode and cathode of the C35 SCR. Note that the current is not rms but average dc. One reason average values are used is that it is much easier to measure average current with a dc ammeter than to find a meter that will read the rms value of a phasecontrolled current. Curves are available that easily convert the average value to an rms value for any conduction angle. The specification sheets for leadmounted SCRs (like the C5 and C106 types) also give the curves for ambient temperature vs average current, since separate heatsinks are not generally used with these devices.

It is very important to appreciate the difference between case temperature and junction temperature. Junction temperature always is higher than case by an amount determined by the thermal resistance (θ) of the device. Parameter θ is



decreases. Thus, average current must be derated to keep $T_{\rm case}$ constant. Data in a plot of maximum forward current vs ambient temperature for various fin sizes (b) is used to help maintain the junction at a proper operating temperature.

May 17, 1966

expressed in degree C rise—junction to case—per watt of dissipated junction power.

Since average heating in the device is determined to some extent by the rms current flowing, the more watts that are generated, the higher the average temperature difference will be between the junction and case. Since the ratio of rms current to average current increases at smallerconduction angles, the allowable average current for a given case temperature must decrease as the conduction angle decreases, if constant rms is to be maintained. This derating at small conduction angles also ensures that the peak junction temperature of the device is not exceeded. Remember that small conduction angles lead to high peak power as well as high average power and that high peak power means high peak junction temperatures. A similar derating is necessary with rectangular current pulses.

Note in Fig. 4a that the case temperature is absolute and defines the thermal gradient between case and junction. For example, if one selected an average current of 8 A at a 30° conduction angle, the maximum allowable case temperature would be 60°C, and one could assume that the junction was close to its rated value of 125°C. Since this particular device usually requires a heatsink to achieve any practical efficiency, the thermal resistance from case to heatsink (°C/watt) and the thermal resistance from heatsink to ambient must be known before values of current for specific ambients can be selected. The curve shown in Fig. 4b has already accomplished this for various fin sizes. It shows the maximum allowable average current, for various conduction angles and different heatsinks, that may be used with the SCR, so as to maintain proper junction temperature.

So much for the input circuit design. Let us turn now to the output circuit, starting with the role of the load.

Device trade-offs based on load

A realistic method for selecting the right device is to investigate the characteristics of the load. Let us then look at three types of typical loads and examine the requirements of each. They are:

- 1. Incandescent lamp load operating from ac supplies.
- 2. Resistance loads of a power factor greater than 99 percent, also operating from ac supplies.
- 3. Inductive loads (phase control of motors, static switching, etc.) with both ac and dc supplies.

Incandescent lamps or tungsten loads.

Two major problems exist for the lamp load applications. First, the in-rush current due to a cold filament condition can be 15 to 20 times more than the steady-state current of the lamp for a single cycle of operation. This means that the SCR or Triac selected should be able to handle the transient in-rush current.

The second problem occurs when the lamp burns out. In this case the lamp filament at burnout has a tendency to arc, thus drawing large amounts of current for a short time interval. An example of a potential misapplication would be to select an SCR that satisfied the steady-state load requirements of the lamp, plus in-rush conditions due to a cold filament, but was unable to handle the burnout condition with high enough reliability. Therefore an SCR of higher power than that required for steady-state conditions should be selected to handle the burnout.

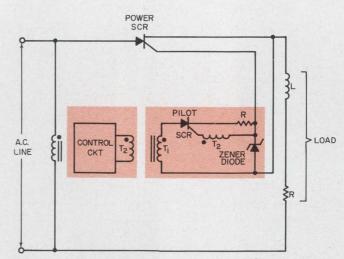
 Non-incandescent resistive loads with a power factor of 99 percent or greater.

With resistive load applications, di/dt and I^2t are generally not problems, since there is no inrush or burnout condition. The device must be selected on the basis of rms-supply voltage and load current. Sufficient heat-sinking must be provided to keep the junction temperature within specifications. In some cases especially when using Triacs) the system inductance (leakage reactance of transformers for instance) can cause some concern. If enough inductance exists in the voltage source supplying the load, commutation dv/dt can be a problem.

The inductance causes a leading phase shift between the voltage applied to the thyristor and the current through it. This means that at the instant the current becomes zero for one polarity of conduction, a voltage is suddenly applied across the device in the opposite polarity. At this instant the thyristor to which forward voltage is applied may conduct, if the rate of rise of the applied voltage is higher than the dv/dt rating of the device. Since control is lost if this happens, external circuitry would be needed to suppress the rate of rise of the applied voltage to within the prescribed dv/dt rating of the device. A simple RC network in parallel with the thyristor does this.

Inductive loads.

One good example of an inductive load is a dc motor driven from an ac supply. Here, an SCR would normally be the logical choice for the following reasons:



5. Time-extended trigger signals must be supplied to the gate of the power SCR in inductive load circuits. Achieved by a separate control transformer, it permits sufficient current build-up in the power SCR to guarantee latching. Alternatively, a series of pulses or a rectangular pulse may be applied to the gate.

Table 1. Classifying SCRs by application

Category	SCR properties	Device characteristics
Light-industrial SCRs	Narrow temperature ranges. Low to medium current ratings. Normal turn-off times.	Passivated structures. Available in plastic case. Typical features (C106): 2 A rms, 25-200 volts. Typical medium current unit (C35): 35 A rms, 25-800 volts.
Heavy industrial and Military SCRs	Wide temperature ranges. Highest current-handling capability. High voltage ratings.	Usually a metal-encased unit. Typical features (2N2542): 235 A rms, 25-800 volts, -40°C to +125°C.
High-frequency SCRs	Rapid turn-off. High current-handling capability. Medium voltage ratings.	Frequency response approaches 50 kHz. Typical features (C141): 35 A rms, 25-400 volts, 10 μ s turn-off.

- 1. With the larger dc motors, the voltage requirement is beyond the range of power transistor technology.
- 2. The power transistor for the smaller motor applications requires separate rectification of the ac voltage supply. If SCRs are used instead, they rectify as well as control.
- 3. In most cases of dc motor speed control, the power loss in the SCR is minimal, compared with the needs of a power transistor operating from a dc supply.
- 4. The locked rotor condition at turn-on is a severe problem, because the only circuit resistance at this time is the motor armature resistance. The SCR inherently has a higher multicycle surge-current rating than that of a power transistor of comparable steady-state ratings. Therefore it is more capable of handling this problem.

For most motors, ac or dc, the problem of commutation dv/dt exists. The use of an RC circuit across the SCR or Triac will limit the rate of rise of the voltage across the device. In full-wave bridge applications for dc motors, the motor inductance causes a holding current to flow through the SCR during the time the supply voltage goes through zero, thus preventing commutation. A free-wheeling diode placed across the load shunts this current away from the SCR, thereby permitting it to commutate properly.

One must also consider the effect of the gate circuit when an inductive load is to be driven. If pulse firing is used, the inductance of the load may prevent sufficient current build-up through the thyristor to ensure that it stays on when the gate pulse is finished. To eliminate this possibility, it is necessary to supply the gate with a sustained trigger signal that lasts as long as the thyristor is conducting (during each forward half-cycle). A typical way of doing this is shown in Fig. 5. The pulse transformer fires into the resistive gate-cathode of the pilot SCR, which in turn fires the power SCR at the desired time. This method is suitable regardless of load power-failure.

Next consider the application itself. Here, factors other than load are used to categorize SCRs. The primary determinants are current, voltage, temperature and switching speed.

SCRs breakdown into 3 types

Today's SCRs can be generally classified under three basic categories: light-industrial types, heavy industrial and military units, and highfrequency devices (see Table 1).

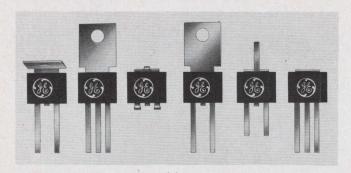
The light industrial SCRs (Fig. 6a) are usually characterized by narrower temperature ranges, low-to-medium current ratings, and normal turn-off times. Low-current devices of planar-passivated structure are now entering this field. These SCRs are characterized by plastic molded cases and are relatively low priced. The planar construction gives a much higher gate-drift stability with junction temperature than the normal, diffused types. Note that this type of SCR may be selected with a tab heatsink. One may visualize the difference in size, case construction, and costs involved by comparing it with the medium-current unit (Fig. 6b).

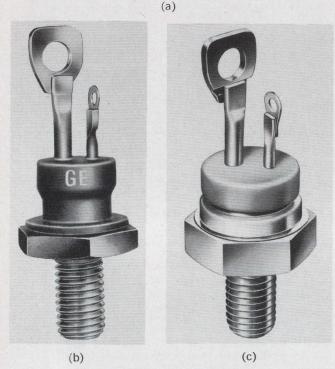
The heavy industrial and military types are characterized by wide temperature ranges, high current handling capacities, and high voltage ratings. Representative of this SCR family is the unit shown in Fig. 6c.

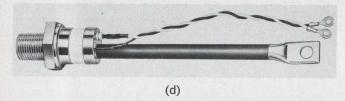
The third general unit is the high-frequency or inverter type of SCR. While this device may generally be classified as a heavy industrial type, it is uniquely characterized by its ability to turn-off rapidly. Figure 6d depicts a typical unit in this category. Note that high-frequency types differ from the heavy industrial units in their application; the former are the only SCRs used in inverters, choppers, cyclo-converters and other higher-frequency applications. Their frequency response is nearing the 50 kHz level; the upper limit for heavy industrial units is closer to 2.0 kHz.

Thus the case is made for the leading member of the thyristor family, the SCR. We now turn to

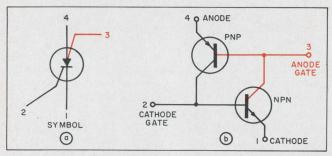
May 17, 1966







6. Thyristors may be classified according to application. Shown are light-industrial (a) and medium-industrial (b) types, a high-frequency unit (c), and a heavy industrial type suitable for military use (d). Type (a) has low-current ratings (to 2 A rms), (b) medium current ratings (to 35 A rms), (d) highest current ratings (typically 235 A rms) and (c) the fastest turn-off time $(10\mu s)$.



7. The SCS is a four-terminal device similar to the SCR. It is suitable for low-voltage and low-power applications (a). The equivalent circuit (b) shows the extra gate (terminal 3), which is sometimes used for preventing dv/dt effects from mistriggering the switch.

its relatives, the SCS, GTO, 4-layer diode, SBS and SUS, LASCR and Triac devices.

Spotlighting the rest of the thyristor family

The remaining thyristor devices are suited for a number of specialized, SCR-like applications (see Table 2). They have not as yet been made available in as wide a variety of package sizes or with as high a power-handling capability as the SCR.

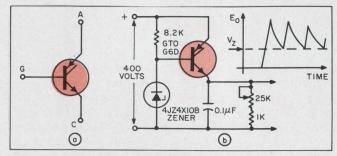
The silicon-controlled switch (SCS), like the SCR, is a pnpn structure. However, it has four accessible leads (Fig. 7). The SCS is a device similar to two complementary transistors connected in a regenerative feedback arrangement. Therefore the normal parameters that cause beta to increase in a transistor, such as V_{CE} , I_C , V_{BE} and temperature, will cause the SCS to unblock (as was the case with the SCR).

The main difference between the SCR and the SCS is that the latter is a four-terminal device used for low-voltage and low-power applications. The extra lead (anode gate) can be effectively used to prevent dv/dt triggering, by returning this gate to the positive supply through a large resistance. The anode gate may also be used as a second gate trigger.

The transient response time of the SCS is dependent on the frequency response of the two transistors and the magnitude of the gate drive current. The larger the gate drive, the less the delay time with low anode currents, and thus the fastest response.

Recovery time, or turn-off time, is a function of diverting the npn base drive current in such a way that this transistor will turn off. This may be accomplished by providing a negative signal to the cathode gate or by placing a short between the anode and the anode gate. By reverse-biasing the anode-cathode junction and tying the cathode gate to a negative polarity or ground, a fast recovery results.

One of the unique features of the SCS is its high triggering sensitivity. At moderate temperatures, where leakage is negligible, very large input resistances may be utilized to provide extremely sensitive triggering levels. Some of the more important parameters of a typical SCS (type 3N82) are:



8. The gate turn-off switch (GTO) is a pnpn device tailored to dc switching application needs (a). It has a higher voltage rating than comparable bipolar transistors, as exemplified by this sawtooth generator application (b). Moreover, its trigger-power requirements are small.

Anode to cathode (forward and 100 volts reverse) voltage (max)

Continuous dc forward current 200 mA (max)
 Total power 400 mW (max)

Operating junction temperature −65°C-150°C
 Holding current 1.5 mA (max)
 Cathode gate current to trigger 1 µA (max)

Turn-on time $1.5 \mu s \text{ (max)}$ Recovery time $15 \mu s \text{ (max)}$

The SCS may be used as a bistable device, such as a Schmitt trigger; as a latching device, with negative gate turn-off; like an SCR, with no dv/dt problems, or as a signal SCR, with an extremely fast recovery time.

GTO a natural for dc switching

The gate turn-off switch (GTO) is a pnpn switching device with three terminals (Fig. 8). The GTO was designed primarily for dc switching applications, where it has these advantages over the transistor: a higher voltage capability and a lower triggering power requirement.

Like an SCR, it may be latched by a positive pulse between gate and cathode; unlike the SCR, it may be unlatched by a negative pulse. A typical GTO is rated up to 400 volts in dc forward-blocking voltage, and it has a 25-volt (dc) reverse-voltage rating. A series diode in the anode lead enables the device to tolerate high reverse voltages when needed. But since the GTO is largely used in dc applications, the diode is a rare necessity. For fast turn-on and turn-off, the positive and negative gate pulses should have steep leading edges and slow decay times. These result in good turn-on and fast recovery times.

SUS and SBS have two states

The unilateral pnpn switching diode, commonly known as the Shockley (or four-layer) diode, is designed to block voltage until the breakover region is attained. The diodes may be obtained at various breakover voltages up to approximately 400 volts. Like the SCR, the switching level is dependent upon the build-up of the breakover current to the threshold point of regeneration. The device then switches to a low saturation voltage level between anode and cathode. This results in a large voltage swing at the time of

Table 2. Other members of the Thyristor cast

Туре	Major application areas	Characteristics	
Silicon-controlled switch (SCS) (see Fig. 7)	Sensitive voltage-level detectors. Binary and ring counters. Oscillators. Time-delay generators. Pulse generators. Relay drivers. Alarm systems.	A 4-terminal device. Used in low voltage (<250 V) and low power (<1.0 w) applications. High triggering sensitivity. Fast recovery time.	
Gate turn-off switch (see Fig. 8)	High voltage flip-flops. Ring counters. Dc converters. High-speed solenoid devices. High-frequency chopping.	A 3-terminal device. Used in dc switching applications typified by higher voltages than transistors and low trigger-power requirements.	
4-layer diode (Shockley diode) unilateral switch; Silicon bilateral switch (SBS) (see Fig. 9) Thresholding control. SCR/Triac phase control. Pulse sharpening. Voltage clipping.		Two regions: blocking and saturation. Forms part of UJT device. Rapid regeneration results in fast response time.	
Light-activated SCR (LASCR) Optical relay control. SCR triggering. Power switching. Alarm systems. Fiber optic programming. Slaved light-activation.		An SCR with a built-in infrared and visible light-sensing capability. Rated to 200 volts at 440 mA dc.	
Triac (see Fig. 10)	Ac phase control. Synchronous switching. Motor-speed control. Lamp dimmers. Automotive systems. Temperature control. Electric heating.	Equivalent to two, inverse-parallel connected SCRs. Immune to voltage transients. May be triggered by ac or dc signals. Maximum peak one-cycle forward current rating is 80 A. Holding current is 50 mA dc (at 25°C). Typical dv/dt rating is 2 V/ μ s.	

May 17, 1966 151

switching, and since the regeneration is very rapid, the response time is much faster than with similar devices.

Another generation of pnpn switches has succeeded the four-layer diode. These devices are the silicon-unilateral switch (SUS) and the silicon-bilateral switch (SBS). They display excellent leakage characteristics, a low breakover voltage and a very good temperature coefficient of threshold voltage. The threshold level is approximately 7 volts, with switchdown to approximately 1 volt. Other representative characteristics are as follows:

Power level

350 mW (max)

Forward current

200 mA

Peak reverse voltage

30 volts (SUS)

Operating temperature

-65°C to 150°C

- Threshold voltag

Threshold voltage tempera- 0.05%/°C (max)

ture coefficient

These devices show promise for applications where accurate control of thresholding (triggering level) under widely varying ambient temperatures is needed. They are also useful in lower voltage phase-control applications. Some units are available with a third lead for low voltage triggering and resetting, such as the UJT. The SBS voltage-current relationship is shown in Fig. 9.

Focus on LASCR for optical control

The light-activated SCR (LASCR) is another device in the thyristor family. It is a small SCR, typically mounted in a hermetically sealed TO-5 transistor case, with a glass window to permit triggering by means of light as well as by the normal gate signal. Typical devices are available up to 200 volts and are rated to 440 mA dc.

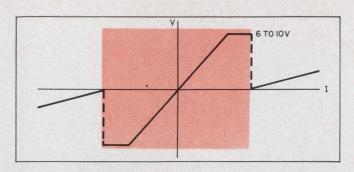
These units were not developed to be highly accurate, threshold light-sensing devices, but they can be used in many applications where the sensing of infrared and visible light spectrums is needed. A typical unit (L8 type) will trigger with an incident irradiation of 0.01 watts/cm² from a tungsten lamp producing 750 footcandles of illumination at the LASCR sensing surface.

The sensitivity of the device depends upon the external gate-to-cathode impedance, the junction temperature and ambient conditions. Moreover the anode voltage, anode current and frequency conditions also affect sensitivity.

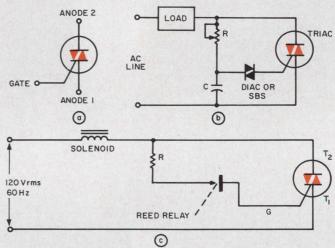
Turn to the Triac for ac control

This recently developed thyristor provides low-cost control in many light-industrial applications. It is used when ac phase control and zero-voltage switching applications demand lower cost than can be provided with inverse-parallel SCRs. The Triac features bi-directional switching of load current with low power gate control (Fig. 10a). Unlike the SCR, the Triac cannot be damaged by voltage transients of either polarity, since excess voltage or dv/dt causes it to conduct, with unwanted power being dissipated into the load.

The Triac may be triggered by ac or dc gate signals, with bi-directional gate voltages for each



9. The silicon bilateral switch (SBS) is a pnpn symmetrical device exhibiting two regions; blocking (high V, low I) and saturation (low V, high I). These are bordered by the breakover limit (point of changing state).



10. The Triac is the equivalent of two SCRs placed in an inverse-parallel configuration (a). In a simple phase-control application (b), the Triac is triggered by an SBS. As a solenoid driver (c), the Triac is easily controlled by a simple reed relay.

anode polarity. For example, when anode 2 is positive with respect to anode 1, the most sensitive triggering polarity is gate-positive with respect to anode 1. Note that a maximum gate current specification for a typical Triac is 50 mA. This is referred to as first-quadrant positive firing. With the same respective anode polarities, the identical Triac may be triggered with negative polarity on the gate, with a maximum specification of 75 mA. This firing mode is referred to as Quadrant I.

Similarly, Quadrant III refers to the opposite anode polarities; III- being the most sensitive (maximum is 50 mA) and III+ being the least sensitive of the four cases, with no maximum gate current guaranteed. However, 75 mA in III+ will trigger the majority of Triacs. The greatest percentage of Triacs will trigger in Quadrant I+ and I- with gate currents between 5 and 25 mA. Selected units may also be obtained for guaranteed specific maximum triggering levels.

At present, typical Triacs may be obtained in two voltage levels, namely 200 and 400 volts, with 6 and 10 A rms forward ratings in each voltage group. For resistive loads, single Triacs can switch up to 2.4 kW on a 240-volt rms line. Triacs are capable of being slave-driven in both phasecontrol and zero-voltage switching circuits. Thus

large amounts of power may easily be controlled. The limiting point in power-handling capability is an economic factor that dictates a comparison between the cost of additional Triacs vs the cost of two high-current SCRs connected inverse-parallel (with their associated firing circuits).

The typical dv/dt capability is 4 volts per microsecond under the conditions of maximum rated rms current, a case temperature of 75° C, and a peak voltage of 200 applied at an exponential rate. Fig. 10b shows a Triac being triggered by a Diac (or SBS) in a simple phase-control application. In this circuit the Triac is being fired in Quadrants I⁺ and III⁻. For each half cycle, the capacitor begins to charge up to the line voltage until the threshold of the trigger switch is reached. At this time the capacitor discharges through the gate circuit of the Triac, switching the Triac ON. It remains latched until the end of the half cycle, at which time the process repeats.

Let us now run through the step-by-step design procedure for a representative thyristor circuit. We choose the Triac device because it typifies a second-generation SCR.

Step-by-step design of solenoid driver

Let us assume we have a solenoid that will be energized with the contacts of a reed type switching relay. We will use a Triac in such a way that the contacts of the reed switch open and close the gate circuit of the Triac, thereby directly switching the solenoid ON and OFF.

The parameters of the solenoid coil are $L=0.1~\mathrm{H}$ and $R=1.0~\Omega$. Line voltage is 120 volts 60 Hz. Since this is a problem of static switching we first draw the proposed circuit diagram (Fig. 10c).

A quick calculation for the full wave, steady state value of inductive reactance is:

 $X_L = j\omega L = j2\pi f L = j 37.7 \Omega$. Since the coil R is 1.0 Ω , the circuit impedance (Z) is approximately j38 Ω . The rms current is

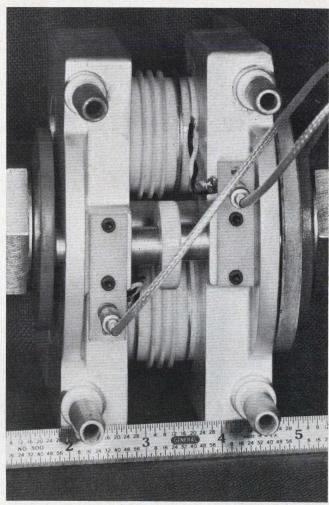
$$I = \frac{120 + \text{j } 0}{\text{j}38} = \frac{120 \angle 0^{\circ}}{38 \angle 90^{\circ}} = 3.15 \angle -90^{\circ} \text{ A}$$
 (2)

Thus we find that the rms current in the anode circuit lags the applied voltage by 90°. We also know that we may use a 200-volt, 6-A rms Triac with a reasonably small heat sink, since the ambient requirement is normal room temperature. The Triac will be triggered in the first quadrant positive (I+) and third quadrant negative (III-) and the maximum gate trigger current needed for either quadrant is 50 mA to insure reliable triggering of all Triacs used.

We select R to be 150 Ω . This insures that the peak gate current is less than the 3-A rating; that the gate power dissipation is not excessive, and that the gate load line provides high gate current for fast switching. To test our final design, we construct the circuit in the laboratory.

After switching on the circuit by energizing the reed switch, we find that we can't turn it off when the reed switch contacts are opened.

Could we have neglected the commutation dv/dt



Don't rule out high-power SCRs! This industrial SCR unit is water-cooled, operates directly from 480-volt distribution lines and can switch 1.5 MW loads. It blocks 1800 volts and can handle 1200 A rms.

of the Triac?

The answer is yes. When the relay contacts are turned off, the Triac will conduct until the load current becomes zero. At this time the line voltage is at a leading phase angle of approximately 90° and the solenoid coil voltage is zero such that the applied voltage is felt directly across terminals T_1-T_2 . Depending upon the distributed capacity of the solenoid, the rate of rise of this applied peak line voltage could very easily be greater than the dv/dt capability of the Triac (typical value = 2 volts/ μ s). A dv/dt suppression network may be required.

The circuit is retested with a new Triac and the dv/dt is checked oscilloscope for the condition of circuit turn-off. Several trials indicate that dv/dt is approximately 5 volts/ μ s and that the Triac remains ON, even though the gate switch is OFF. A suppression network of 0.1 μ F in series with a 100 Ω resistor is placed in parallel with T_1-T_2 and the circuit performs satisfactorily for all Triacs tested.

References:

- 1. General Electric SCR Manual, Third Edition
- 2. "Di/dt failures in SCR circuits—their cause and prevention," By R. Weschler, Electronic Design, Aug. 16, 1965, pp 140-145.
 - 3. General Electric Transistor Manual, Seventh Edition

a little...

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- 5. WEIGHT: N120CG .18 Gr. Avg. N220CG .36 Gr. Avg. N210CG .18 Gr. Avg. N230CG .54 Gr. Avg.

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Test Temperature: 28°C ± 2°C.

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Hoffman solid state photo-sensing devices are now being used for measuring, cloth cutting, sequence counting, liquid level gauging, data processing and other manufacturing functions requiring absolute accuracy.



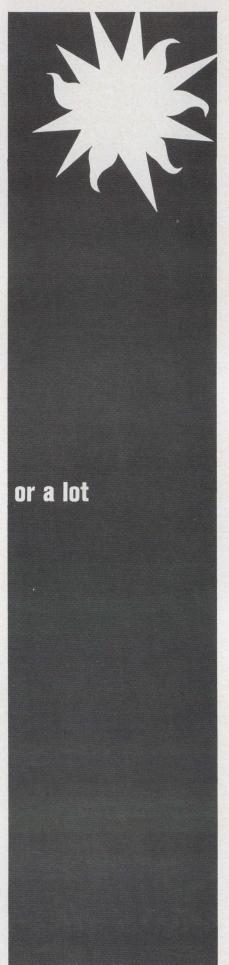
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In choosing diodes, don't settle for second best. Nearly all are optimized for a specific characteristic, so use this application guide to pick a winner every time.

Few engineers realize that each diode type, including general-purpose, has been tailored to meet the needs of a specific class of applications. This "application-fitness," achieved by V-I characteristic, electrical parameter control, package, or wafer construction, is the governing criterion for choosing the best diode for the job.

In line with this we have drafted a table of the major diode categories to help with selection.* It contains information on key application areas, critical design parameters and salient characteris-

tics for the most popular diode types.

Although a diode may be used with some measure of success in an application other than the one it has been optimized for, chances are that one or more of its parameters will be compromised and efficiency, life, or some other vital characteristic shortchanged. By contrasting the characteristics of different types, the table should give a clue to their suitability for any application.

To supplement this contrast and selection information, here is a breakdown of the maximum ratings and electrical characteristics common to nearly all diode types. This examination includes the definition and procedures used in calling out

these diode parameters.

Maximum ratings

■ $V_{RM(wky)}$ —Reverse voltage rating; the rated repetitive peak working voltage of a device is usually specified below the avalanche breakdown voltage to provide the safety factor required in the application for which it is designed. Higher voltage devices must sometimes be derated as a function of operating temperature due to forward and reverse power dissipation and increase leakage at elevated junction temperatures.

■ I_o —Average rectified forward current; this rating defines the current rating of diodes designed for use primarily in rectifying applications. It is determined by the manufacturing process, wafer size, and package design, and is rated as a function of operating temperature.

 \blacksquare I_{FM} —Peak forward current; this rating defines the recurrent peak forward current which

may be seen by the diode. An example of a severe case is operation of the diode in a capacitive-input filter circuit. I_{FM} is usually derated as a function of temperatures.

- $I_{FM(surge)}$ —Surge current; this is the non-repetitive current rating. It is usually specified as the current which a rectifier may be subjected to for a given number of times (usually 100) without failure, and as such, is a fault-condition rating. Some manufacturers provide a more conservative surge rating which is not limited to a given number of occurrences. That rating may be used to determine the safe inrush current in capacitive-filter type applications. It normally assumes that the device is allowed to return to thermal equilibrium prior to re-application of the surge.
- P—Power dissipation; the maximum power dissipation capabilities of the device under the conditions defined on the data sheet.

Electrical characteristics

- \blacksquare V_{BR} —Reverse breakdown voltage; this is specified as a minimum characteristic of the diode, usually at a low leakage current and at a specific temperature.
- I_R —Static reverse current; the reverse leakage current under specified reverse bias and temperature.
- V_F —Static forward voltage; the forward voltage drop at a stated forward current and temperature. Usually measured with pulse techniques to overcome junction heating errors. ■



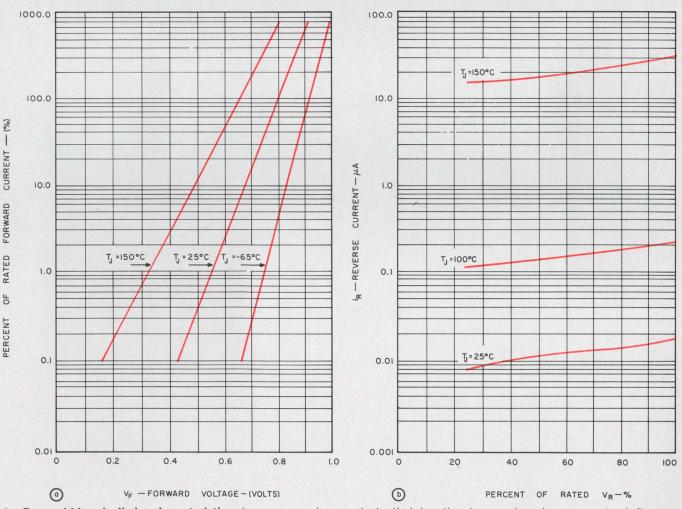
Pinpointing diode parameters. Author McKenna works out the design of a diode circuit. He developed the applications-oriented guide to selecting diodes and rectifiers so as to save time and optimize circuit performance.

Robert G. McKenna, Senior Engineer, Texas Instruments Inc., Semiconductor Division, Dallas, Tex.

^{*}This table is tailored to the "who-makes-what" chart in the diode section of this Directory (pp. 164). The table does not include thyristors, which are covered in a separate article (see p. 144).

Applications - Oriented Parameter Study

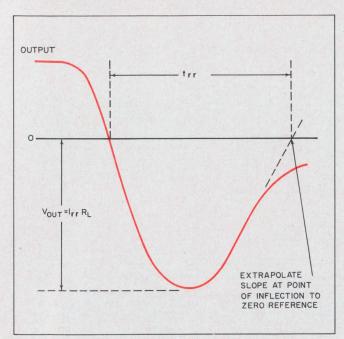
Device type	Major applications	Governing parameters	Key characteristics
General purpose diodes (Fig. 1)	Low-power rectification with capacitive inputs (voltage-doublers, triplers).	I _{FM} (surge) for inrush current. I _{FM} for peak, recurrent operating current.	Devices optimized for high-forward trans- conductance. Application typified by medium voltage levels (1 - 600 volts).
	Low-power rectification with inductive inputs (L-filters, high-L transformers, magnetic amplifiers).	Peak transient reverse voltage rating.	
	Clamping, decoupling, biasing circuits, dc relay networks.	Forward transconductance.	
Rectifiers (Fig.2)	Power rectification (includes conventional rectification, high-voltage power supplies, photomultiplier tube biasing, radar and infrared systems).	Average forward current rating. Peak reverse voltage rating. Power dissipation. Surge current. Peak transient reverse voltage rating. Thermal resistance. Transient thermal impedance.	Devices are high-power diodes especially packaged for rectifier service. Units are optimized for high forward-conductance and minimum thermal impedance.
Fast-recovery rectifiers	High-frequency converters, multiphase rectifiers and high-speed power switching.	Reverse recovery time. Reverse recovery current. Total device capacitance.	Typified by recovery times of the order of 100 ns.



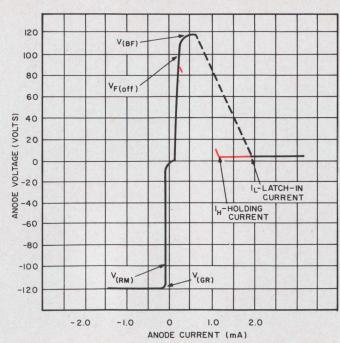
1. Forward-biased diode characteristics for a generalpurpose type show how temperature affects the V-I relationship (a). The reverse-biased characteristics demon-

strate that junction temperature has a greater influence on the reverse current than that due to the applied reverse voltage (b).

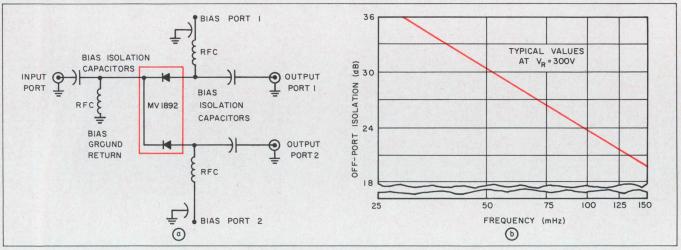
May 17, 1966



2. Reverse recovery time is a critical parameter in rectifiers. Denoted by $t_{\rm pr}$, its measurement requires that a slope extrapolation be made.

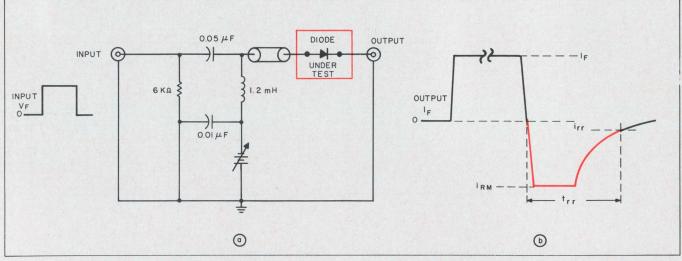


5. Current vs voltage relationship for a reverse-blocking diode thyristor shows how a blocking characteristic is achieved in this device.



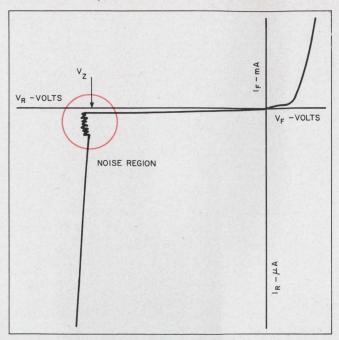
3. **RF diodes** are often used to switch high-frequency signals (a). Plot of off-port isolation vs frequency (b) shows that the series resistance of the diode at 1 kHz

is within 15% of its value at 50 MHz. This magnitude is usually less than 1.0 $\Omega.$ Note that $\rm V_R$ refers to the reverse voltage.

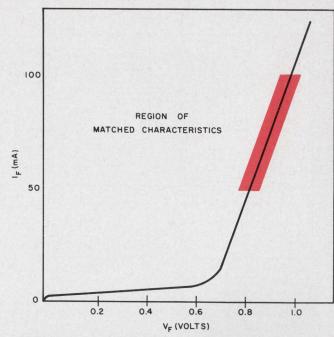


4. A critical parameter for computer and high-speed diodes is the reverse recovery time, $t_{\rm rr}.$ Measured by the

test circuit (a), it is calculated from observations of the output-current waveform (b).



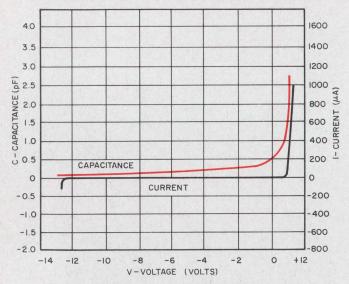
6. Noise diode characteristic shows the useful operating region (at the point of avalanche breakdown) for white noise generation.



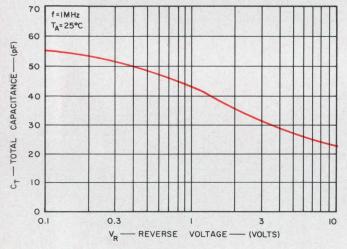
7. Forward voltage drop is the criterion for establishing the region of matched characteristics for matched-diodes. Current level and temperature are the other key factors.

Applications - Oriented Parameter Study (continued)

Device type	Major applications	Governing parameters	Key characteristics
RF diodes (Fig. 3)	RF detection circuits. Small-signal, low-voltage diode applica- tions.	Reverse recovery time.	Units have small-area junctions for minimum capacitance.
Computer and high-speed diodes (Fig. 4)	Diode gates, diode-capacitor storage, low-power diode switching and other "speed" applications.	Reverse-recovery time (<300 ns), Low junction-capacitance (<4pF at zero volts).	Typified by reverse voltage ratings < 100 volts and forward voltage drops of 1 volt (approx.) at 10 - 50 mA. Note that forward transconductance, surge current ratings and reverse voltage ratings are relatively poor here.
Reverse-blocking diode thyristors and 4-layer diodes (Fig.5)	Low-power circuits (bistable circuits, switching circuits, ring counters and SCR triggering). High-power circuits (power switching, squib firing, pulse-forming, tone generators, proportional power control).	Working blocking voltage. Anode breakover voltage. Average forward current. Peak recurrent forward current. Power rating. Conducting voltage drop. Holding current. Latching current. Allowable rate of dv/dt.	Blocking characteristic exists until a breakover value is reached; then devices switch through a negative-resistance region into a low-impedance conducting state.
Noise diodes (Fig. 6)	White noise generation. Random noise source in ECM jamming equipment. Random function generator (vibration table drives).	Available noise level. Bias voltage requirements.	White noise is generated at the point of avalanche breakdown.
Matched diodes (Fig. 7)	Critical biasing circuits. Differential circuits. Logarithmic attenuators. Signal limiters.	Forward voltage drop.	Matched at several different current levels and (if required) at various temperatures.
Microwave diodes (Fig. 8)	Parametric amplifiers. Parametric limiters. Microwave switches. Phase-shifters. Harmonic generators. Sub-harmonic oscillators.	Total capacitance, C _T . Cutoff frequency, f _{co} . Figure of merit, Q. Noise figure, NF. Package inductance. Power and voltage ratings.	Optimized for use at frequencies above 1 GHz.

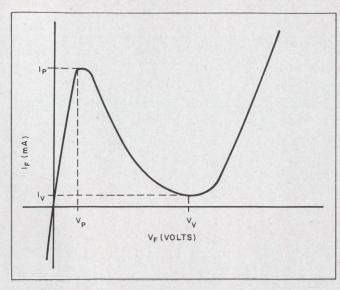


8. Junction capacitance, a key design parameter, and diode current are non-linear functions of voltage in the microwave diode.

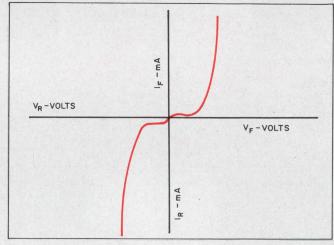


9. In varactor diodes, the total capacitance $C_{\rm T}$ is inversely related to reverse voltage $V_{\rm R}.$ Two to five times the nominal capacitance is the range available.

Applications - Oriented Parameter Study (continued)



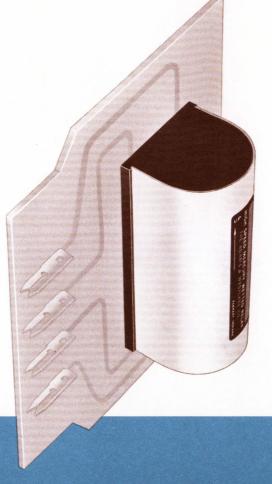
10. The various operating regions and threshold levels of the tunnel diode are depicted in this forward current-forward voltage characteristic.



11. Symmetrical characteristics in varistors are obtained when two identical diode junctions are placed in an inverse-parallel configuration.

Device type	Major applications	Governing parameters	Key characteristics
Varactor diodes (includes variable reactance types) (Fig. 9)	Automatic frequency-control. Voltage-variable tuning circuits. Harmonic generation. FM modulators.	Normal peak reverse voltage. Power dissipation. Total device capacitance, C _T . Capacitance ratio, C _{V1} /C _{V2} . Figure of merit, Q.	Optimized for their voltage - variable junction capacitance. Peak reverse-voltage ratings range between 15 and 100 volts. Device capacitance is between 2 and 50 pF and capacitance ratio range is 2.0 to 5.0.
Tunnel diodes (Fig. 10)	Memory units. Logic circuits. Oscillators. Amplifiers.	Peak current, I _P . Valley current, I _V . Current ratio, I _V /I _P . Valley voltage, V _V . Delta voltage, V _V - V _P .	Provide a negative-resistance character- istic in the forward-bias region below the stand-off voltage.
Varistors (Fig. 11)	Signal-limiters. Audio-clipper circuits. Noise and transient suppression. Meter protection.	Non-linear impedance vs voltage characteristic.	Usually two diode junctions connected in an inverse-parallel configuration.





high speed mercury wetted relays

Intended for printed circuit board mounting, relay types AWNA, AWPB, AWCA, AWCL, and AWCS introduce a new concept in relay design. Created to serve as an alternate for currently available Single and Two Switch mercury wetted contact relays, this feature, plus the inherent superior characteristics of Adlake mercury wetted contact relays, make these devices sought after by circuit and equipment designers.

Available in either neutral, form D, bridging type or sensitive, form C, non-bridging type, the devices represent another group of Adlake quality mercury wetted contact relays. Single and dual windings-bifilar and/or concentric wound are available for all relay types.

A few of the advantages of mercury wetted contact relays, such as freedom from contact bounce, high operating speeds (up to 200 times per second), long life and adequate current ratings add to the attractiveness of these new devices. See Bulletin No. 1263AW—193A20M for explicit data on current ratings. For contact protection network data see back cover of this bulletin.

Simplicity of design has eliminated costly and weightadding parts. Gone are base plates fabricated from insulating materials that can be responsible for unexplained failures. Solder joints are held to a minimum, as additional insurance against relay malfunction.

Covers are fabricated in a simple form from soft iron.

A finish is provided to insure the esthetic quality of the relay throughout the device's life. The cover serves to protect the switch element and coil. Magnetic interaction between adjacent relays is minimized through the use of moderate gauge metal. (See interaction chart on reverse side for detailed dimensions).

Relays are potted with either silica filled epoxy or polyurethane compounds. No wax is used, which eliminates the possibility of wax contamination under high operating temperatures. If desired, the relays can be supplied less the cover—available upon special order. (Note: For applications demanding excellent chemical resistance of its components, we recommend the epoxy filled relay).

The following chart describes the relays in this series in general terms and identifies them with the presently available single switch mercury wetted contact relays.

Catalog Type	Contact Form	Related to Adlake Catalog Type
AWNA-1600	Neutral, Form D	MW-1600
*AWPB-16000	Polarized, Form D	MWP-16000
*AWCA-16000	Sensitive, Form C	MWS7 & MWSA-16000
*AWCL-16000	Sensitive, Form C	MWSL-16000
AWCS-26000	Sensitive, Form C	(None)
AWNA-2600	Neutral, Form D	(None)

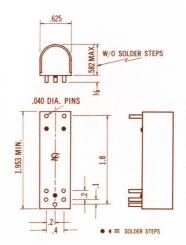
^{*}Available as single-side-stable; bi-stable or chopper.

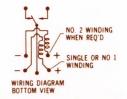


ake form C sensitive mercury wetted contact relays

type AWCA -16000 (single switch)

catalog no.	coil		coil current milliamperes	
	resistance ohms	turns	must operate	must release
AWCA-16011	2,400	7,700	7.8	1.3
AWCA-16021	4,000	15,000	4.0	0.67
AWCA-16041	675	5,200	11.6	1.9
AWCA-16121	115	2,000	30.0	5.0
AWCA-16261	450	4,650	12.9	2.1
AWCA-16351	940	5,800	10.4	1.7
AWCA-16511	65	1,575	38.1	6.3
AWCA-16541	1,250	6,400	12.1	1.6
AWCA-16571	1,950	7,375	8.2	1.3
AWCA-16581	1,425	7,125	8.4	1.4

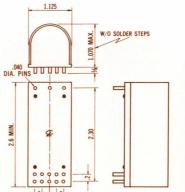




To prevent the accidental bridging of terminal pins with accumulated solder, solder steps or standoffs are used. When included in the relay design the front to back dimension (projection) is increased by 1/32". Note: This feature is optional and will be included upon request, at no increase in cost.

type AWCL - 16000 (single switch)

catalog no.	coil		coil current milliamperes	
	resistance ohms	turns	must operate	must release
AWCL-16011	2,500	18,800	1.43	0.17
AWCL-16021	4,000	23,400	2.0	1.0
AWCL-16091	7,000	31,675	0.87	0.14
AWCL-16121	130	4,900	5.58	0.96
AWCL-16191	40	2,800	12.2	3.8
AWCL-16241	25,000	53,000	0.52	0.09
AWCL-16261	500	9,450	2.89	0.50
AWCL-16421	350	7,660	3.56	0.61
AWCL-16431	1,000	12,350	2.21	0.38
AWCL-16721	11,000	38,050	0.72	0.12

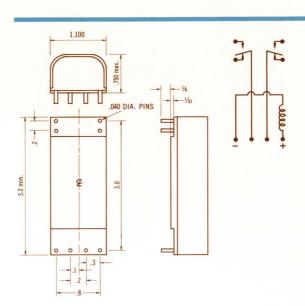


To prevent the accidental bridging of terminal pins with accumulated solder, solder steps or standoffs are used. When included in the relay design the front to back dimension (projection) is increased by 1/32". Note: This feature is optional and will be included upon request, at no increase in cost.

WIRING DIAGRAM BOTTOM VIEW

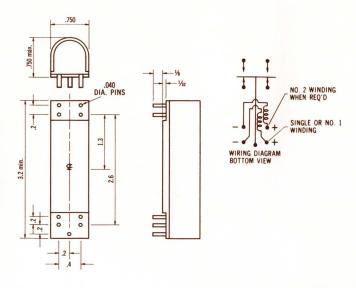
type AWCS-26000 (two switch)

catalog no.	coil		coil current milliamperes	
	resistance ohms	turns	must operate	must release
AWCS-26021	540	7,800	11.5	1.3
AWCS-26071	2,350	14,000	6.4	0.7
AWCS-26121	140	3,500	25.7	2.8
AWCS-26451	40	2,000	45.0	5.0
AWCS-26541	1,250	10,000	9.0	1.0

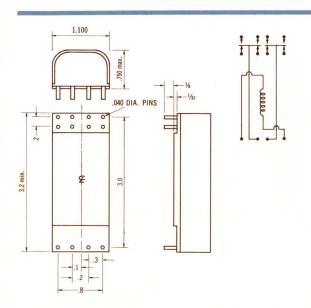


form D neutral mercury wetted contact relays





Relay types AWNA and AWPB are identical in size and configuration. Each is a single switch-Form D-neutral (bridging) type relay, and is available with either single or dual wound coil. Relay type AWPB is polarized by means of permanent magnets and is available in Single-Side-Stable, Bi-Stable or Chopper form.



typeAWNA - 1600 (single switch)

catalog no.	coil		coil current milliamperes	
	resistance ohms	turns	must operate	must release
AWNA-1601	2,000	10,550	18.0	8.0
AWNA-1604	750	7,825	24.3	10.7
AWNA-1605	50	2,000	95.0	42.0
AWNA-1613	200	3,800	50.0	22.1
AWNA-1615	1,500	9,580	19.9	8.8
AWNA-1626	450	5,675	33.5	14.8
AWNA-1648	20	1,225	155.0	68.6
AWNA-1651	70	2,250	84.5	37.3
AWNA-1653	4,300	14,200	13.4	5.9
AWNA-1654	1,100	8,350	22.8	10.0

$type \, A\overline{WPB}$ - 16000 (single switch)

catalog no.	coil		coil current milliamperes	
	resistance ohms	turns	must operate	must release
AWPB-16011	2,000	10,650	6.7	0.5
AWPB-16041	750	7,825	8.9	0.7
AWPB-16051	50	2,000	35.0	2.9
AWPB-16131	200	3,800	18.4	1.4
AWPB-16151	1,500	9,580	7.3	0.6
AWPB-16261	450	5,675	12.3	0.7
AWPB-16481	20	1,225	57.2	4.5
AWPB-16511	70	2,250	31.0	2.4
AWPB-16531	4,300	14,200	4.8	0.4
AWPB-16541	1,100	8,350	8.4	0.6

type AWNA-2600 (two switch)

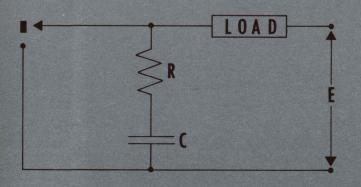
catalog no.	coil		coil current milliamperes	
	resistance ohms	turns	must operate	must release
AWNA-2602	540	7,800	27.5	12.0
AWNA-2607	2,350	14,000	15.7	6.9
AWNA-2612	140	3,500	62.8	27.7
AWNA-2645	40	2,000	110.0	48.5
AWNA-2654	1,250	10,000	22.0	9.7



high speed mercury wetted relays

contact protection

Except for specific instances of light loads, the relay contacts must be protected by a network composed of a resistor and a capacitor in series as shown in the following diagram. This protection should be physically located as close as possible to the relay terminals.



Contact Protection Network to be used with ADLAKE Neutral Type MW and Sensitive Type MWS Relays

The preferred values of R and C, except for the conditions stated subsequently, can be evaluated from the following equations:

(1)
$$C = \frac{I^2}{10}$$
 microfarads

(2)
$$R = \frac{E}{10 \text{ I}^{\times}} \text{ ohms}$$

$$X = 1 + \frac{50}{E}$$
here $I = \text{load current in amperes immediately prior to$

where ${\bf I}={\sf load}$ current in amperes immediately prior to opening of contacts.

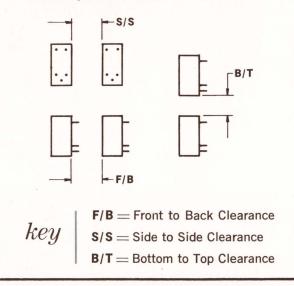
E = source voltage immediately prior to closing of contacts.

A	В	С	D
Less than 50	Less than 2.5 amperes	Use calculated value	May be omitted
Up to 70	All other conditions	Use calculated value	3 X calculated value permissible
@ 100 v.	All other conditions	Use calculated value	Within 50% of calculated value
@ 150 v.	All other conditions	Use calculated value	Within 10% of calculated value
Above 150 v.	All other conditions	Use calculated value	Follow calculated value closely

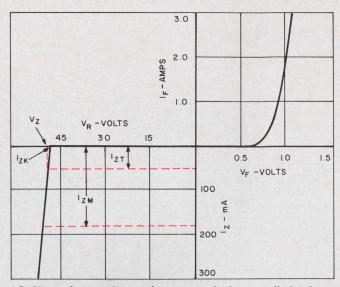
Note: For any voltages more than 50, the value of R must not be less than 0.5 ohm.

magnetic interaction data

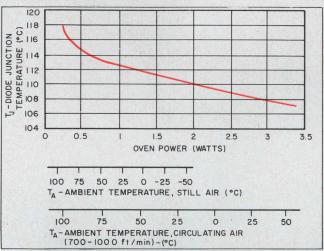
Magnetic interaction is described as the unauthorized operation or variation in characteristics of a relay adjacent to another relay, when either device is energized or is being removed from the equipment. The following dimensions must be observed to insure that interaction between relays is eliminated.



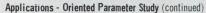
Catalog Type	F/B	S/S	B/T
AWNA	0"	0"	1/4"
AWPB	0"	0"	3/8"
AWCA	0"	0"	1/4"
AWCL	0"	0"	1/4"
AWCS-26000	0"	0"	1/4"
AWNA-2600	0"	0"	1/4"

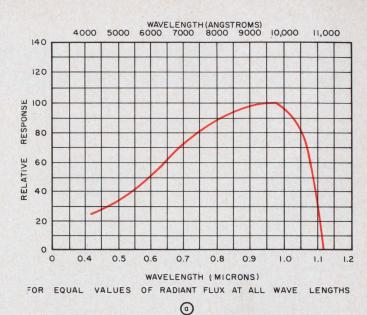


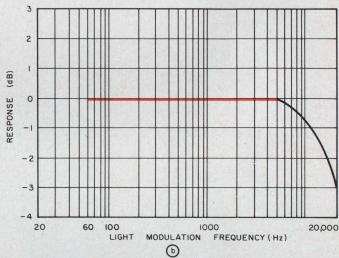
12. Normal operating region in a typical zener diode characteristic is between $I_{\rm ZK}$ and $I_{\rm ZM}.$ The normal quiescent bias point is at $I_{\rm ZT}.$



13. Wide-range ambient temperature excursions (ΔT_A) have little influence on the junction temperature (T_i) and oven power (W) in this compensated reference diode.







14. Photo diodes exhibit a variable response (impedance) over a portion of the wavelength spectrum (a). Note, however, that their frequency response (b) is fairly flat.

Device type	Major applications	Governing parameters	Key characteristics
Zener diodes (Fig. 12)	Reference elements. Shunt-voltage regulators. Voltage-reference elements. Biasing networks. Interstage coupling. Suppression circuits. Voltage clipping.	Zener breakdown voltages, V _Z . Temperature-coefficient of zener voltage, $\Delta V_Z/\Delta T_A$. Dynamic Zener impedance, Z _Z . Power rating, P _D .	Operate in avalanche-breakdown region. Voltage ranges between 3 and 250 volts; power rating is from 150 mW to 50 W.
Low temperature-coefficient reference diodes (Fig. 13)	Voltage reference elements. Standard cell replacements. Critical voltage regulators.	Zener voltage, ${\rm V_Z}$. Temperature coefficient, $\Delta {\rm V_Z}/\Delta {\rm T_A}$. Power requirements.	Usually a series combination of selected low-voltage Zener diodes and forward-biased diodes. Fixed bias current operation is recommended.
Photo diodes (Fig. 14)	Character recognition. Card/tape readouts. Photoswitching. Proportional control systems. Difference amplifiers. Latching networks. Light-sensing. Photo-modulation.	Light current, I _L . Dark current, I _D . Total capacitance, C _T . Rise time and fall time. Spectral response.	Output impedance is usually inversely proportional to radiated light power levels.

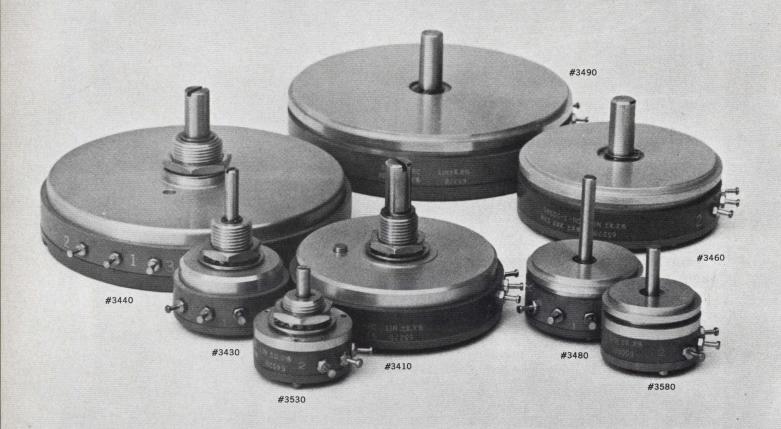
One Good Single-Turn Calls for Another... Now Bourns Offers You Eight!

Whenever it's a question of single-turn precision potentiometers, you get <u>more</u> and <u>better</u> answers from Bourns. Here's the all-star lineup:

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Model 3530, 7/8"	Model 3580, 1/8"
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Model 3410, 2"	Model 3460, 2"
Model 3440, 3"	Model 3490, 3"

In this complete single-turn line, the quality matches the

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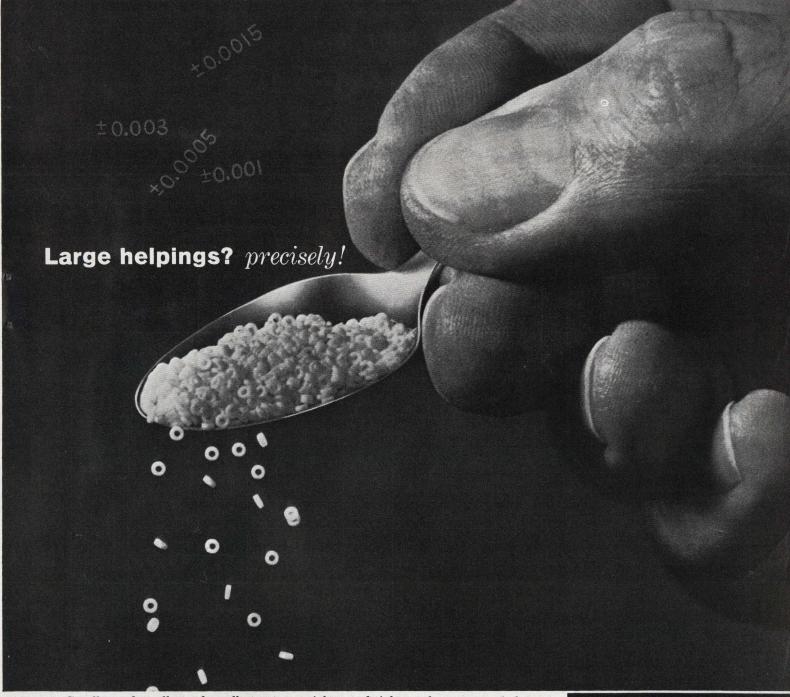


Bourns' thin design lets you gang units in minimum depth; for example, Model 3580 allows 24 cup sections in less than 6 inches.



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1966 Diode Manufacturers' List (According to Device Type)

To find the manufacturers of a specific type of diode, locate the device type in the columns on top. Dots are placed in the column to identify the manufacturers, listed at the left.

To determine the diode product line of a specific manufacturer, locate the company name in the horizontal rows at the left. Dots are placed in that manufacturer's row under each type of diode device that forms a part of his product line.

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Airtron Div., Litton Industries							•	•	•								
Alpha Industries Inc.			•		100			•	•								N, P
American Electronics Labs. Inc.			•					•	•								N, R
American Semiconductor Inc.							•					•	•	1766			
Amperex Electronic Corp.	•	•	•	•	•		•		•			•	•			•	D, F
Atlantic Semiconductor Inc.		•															B, H, St
Bell, F. W., Inc.		, A-1, E.												7			На
Bendix Semiconductor Div.	•	•								1							
Bradley Semiconductor Corp.	•	•														*	
Burroughs Corp.	•			•				8							•		
C B S Laboratories				304								•	•	10	The same	•	
Chatham Electronics	•													•			В
Computer Diode Corp.	•	•	•	•			•	•	•		•	•	•				C
Conant Labs.		•															B, Se
Continental Device Corp.	•	•	•	•		•	•	•				•	•	•			
Crystalonics Inc.							•		•								
Delco Radio Div., Gen. Motors	•	•												10,100			D
Delta Semiconductors Inc.	•	•	•	•		•	•	•	•			•	•				F
Dickson Electronics Corp.		•			17151		•			•		•	•				
Diodes Inc.	•	•		•			•					•					B, D, H, St, S
Eastern Delta Corp.		•									•			30.5			B, S, St
Eastron Corp.			1				•		•			•					C, St
Edal Industries		•					•				•	1		1			B, Df, H, S
Edgerton, Germeshausen & Grier					9.68			1974		77.0	11111			100		•	R
Electro-Optical Systems Inc.													K	12.00		•	
Electronic Devices Inc.	•	•										•					B, D, H, M, V
Erie Technological Products	•	•		•			•										В
Fairchild Semiconductor	•	•	14/20	•		•	•	•	•			•	•	•		•	A, E
Fansteel Metallurgical Corp.		•															Se
General Electric Co.	•	•	•	•	•		•	•	184.5	•	•	•	•	•	•	•	La, P

Key to special purpose diodes category

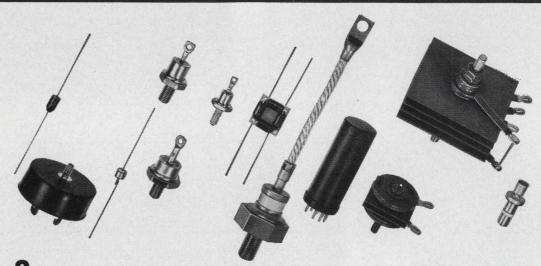
A	= Arrays	N = Pin diodes
В		
	= Bridges, stacked, or special assemblies	
Bi	= Bilateral switch	Ph = Photo SCRs
C	= Multi-junction forward regulators	R = Radiation detectors
CC	= Constant-current source	S = Suppressors
D	= TV dampers	Se = Selenium rectifiers
Df	= Specially diffused silicon diodes	St = Stabistors
E	= Light emitting diodes	Sym = Symmetrical switch
F	= Controlled forward conductance diodes	T = Thin-film applications types
Н	= High voltage elements	Tr = Trigger diode
Ha	= Hall effect generators	U = Multi-current reference
La	= Lasers	Y = Relay diode

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General Semiconductors Inc.	•	•					•		•			•	•				B,C,H,U
Green Rectifier Corp.		•	9								•						B, S, St
H P Associates	•		•	•			•	•								•	E, N, P, F
Heliotek Div. Textron Elec- tronics Inc.																	
Hoffman Electronics Corp.	•	•		•		•				•	W.11	•	•	•			
Hughes Aircraft Co. Microelec- tronics Div.	•																A
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Instrument Systems Corp.				180	77.19		7.1			1241		- 1					На
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International Electronics Corp.	•	•	•	•			•		Thur !			•		•		•	
International Rectifier Corp.	•	•								12.13	HANN	•	•	•			
IRC Semiconductor	•	•							A 334		9 50 12	•	•	•			В
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MSI Electronics Inc.	THE REAL PROPERTY.							•	•			199				77.8	
Mallory Semiconductor Co.		•										•	B/a			1.535	B, Tr, St
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Microstate Electronics Corp.				•			•		•	•							E, N, X
Microwave Associates Inc.			•				•	•	•	•							N, P, Df
Motorola Semiconductor Products Inc.											land .	•					CC, B, Tr
National Electronics Corp.					1									•			
Nucleonic Products Co., Inc.	•	•	•	•			•		•		•	•	•	•		•	В
Ohmite Mfg. Co.	•	1	•	•			•					13,27					
Philco Corp.	•		•	•				•	•	•						•	B, CC, La, N, P, Ph, F Sym, T, U, Y
Power Components Inc.	•	•			•	14000	•					•	•				St

May 17, 1966

Tarzian value-researched

Some research develops new products...some research develops better products at lower cost...



Comprehensive design engineering data, including applications, test circuits, manufacturing methods and detailed electrical and mechanical specifications are available on Tarzian Semiconductors. This is just one phase of Tarzian value oriented service that includes application engineering assistance, MIL testing, quick quotations, fast sampling and competitive prices.

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Avalanche characteristics standard at no extra cost. Low Current (1.0—1.6 amps DC, 100—800 PIV) Medium Current (2—12 amps DC, 100—600 PIV) High Current (25—350 amps DC, 100—600 PIV) High Voltage Cartridges (to 30,000 PIV, 50-250MA) Tube Replacement (over 25 types available)

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0.25-50 watts, 5.6-200 volts-over 940 IN types in 5 voltage ratings and 8 series

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SELENIUM RECTIFIERS

20-320 volts, full wave, half wave, single phase, three phase, open, embedded, metal enclosed, and dozens of special types

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SILICON CONTROLLED RECTIFIERS

3-5 amps 100-600 volts

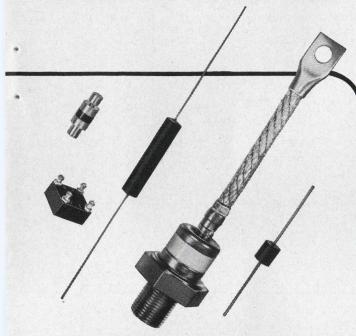
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semiconductors

TARZIAN CONDUCTS ALL THREE KINDS



KLIPVOLT SURGE SUPPRESSORS

63—1020 max. clamping volts single phase non-polarized; peak discharge current .2 to 180 amps. 22—272 max. d-c blocking volts single phase polarized; max. discharge current .25 to 430 amps.

85—600 max. clamping volts three phase, nonpolarized; peak discharge current 2.5 to 180 amps. Check 196 Reader Service Card

The highly condensed listings shown here represent literally thousands of different types of semiconductor rectifiers. Complete listings of standard units are given in the technical publications covering each product group. Special types can be designed to meet your specifications. Contact your local Sarkes Tarzian sales representative or write directly to us for details.

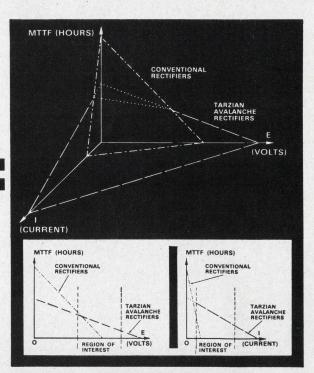
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on most types is available through a nation wide network of Tarzian Industrial Electronic Distributors.

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TARZIAN AVALANCHE RECTIFIERS WITH UP TO 125% GREATER MEAN TIME TO FAILURE*

A 2,000,000 unit hour test program recently completed by Tarzian shows statistically significant advantages for avalanche rectifiers and shows that the derating-safety factor concept is not applicable to avalanche rectifiers.

TEST METHODS: Random samples were tested on an automatic life tester which provided load conditions closely approximating usual field operation. Daily test results of peak inverse voltage and forward voltage drop were automatically recorded and accumulated. Current and voltage variant sub-samples were used to test efficacy of derating-safety factor procedures.

TEST CONCLUSIONS: Greater MTTF is exhibited by Tarzian avalanche rectifiers than by standard types without avalanche characteristics. When moderate, long term overloads are applied (133% of rated current), avalanche rectifiers have a minimum improvement of MTTF of 125%. At rated current, avalanche rectifiers have as much as 123% improvement of MTTF, and a minimum of 6% improvement in MTTF. Derated 33% from rated current, avalanche rectifiers have a 20% improvement in MTTF over conventional rectifiers.

*with 95% confidence

Key to special purpose diodes category

= Pin diodes = Arrays = Bridges, stacked, or special assemblies = Snap diodes Bi = Bilateral switch Ph = Photo SCRs C = Multi-junction forward regulators = Radiation detectors S CC = Constant-current source = Suppressors Se = Selenium rectifiers = TV dampers Df = Specially diffused silicon diodes St = Stabistors = Light emitting diodes Sym = Symmetrical switch = Controlled forward conductance diodes T = Thin-film applications types = High voltage elements Tr = Trigger diode Ha = Hall effect generators = Multi-current reference La = Lasers = Relay diode

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Raytheon Co.	•		•	•			•	•	•	•		•	•			•	E, N
Rectico Inc.		•										F. S.					
Saratoga Semiconductor Div., Espey Mfg.							A.										
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Silicon Transistor Corp.					1									•	•		
Slater Electric Inc.		•															
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Solid State Products Inc.					•									•	•	•	Ph
Solitron Devices Inc.	•	•	•			•	•	Total Inc	•		•	•	•	3			N
Sylvania Electric Products	•	•	•	•		•	•	•	•	•	•		18		•		N
Syntron Co.		•													•		В,Н
T R W Semiconductors	•	•	•	•			•	•	•			•	•				St
Texas Instruments Inc.	•	•	•	•	•		•	•	•	•	•	•		•	•	•	E, L, St
Transitron Electronic Corp.	•	•	•	•		•	•	•		•	1	•	•	•	•		U
Trio Laboratories Inc.					1167			1			No.	•			The second		CC
Unitrode Corp.	•	•		•	•		•					•	•				B, C, H, N, S
Vactec Inc.														17.5		•	
Varian/Bomac Div.						-	•	•	•			No. of Street					N, P
Varo, Inc., Special Products Div.		•		•		1			1000								H, B, D, Df
Western Semiconductor Inc.	•	•		•	•	•	•		•		•	•	•	•	•		В
Westinghouse Electric Corp., Semiconductor Div.				•							* *	•		1			

SILICON TRANSISTOR CORPORATION



SILICON NPN AND PNP POWER TRANSISTORS



Silicon Transistor Corp. makes more different silicon power transistors than any other manufacturer.











NPN Types

Туре	Case Type	Pd Watts 100°C Case	BVCEO Volts	hfe Min.	@ Ic Amps.	VCE(sat.) Volts Max.	@ Ic Amps.
2N1016B	150W	71	100	10	5	2.5	5
2N1016C	150W	71	150	10	5	2.5	5
2N1016D	150W	71	200	10	5	2.5	5
2N1483	T0-8	14.1	40	20	0.75		0.75
2N1484	T0-8	14.1	55	20	0.75		0.75
2N1485	T0-8	14.1	40	35	0.75		0.75
2N1486	T0-8	14.1	55	35	0.75		0.75
2N1487	T0-3	43	40	15	1.5	3.0	1.5
2N1488	T0-3	43	55	15	1.5	3.0	1.5
2N1489	T0-3	43	40	25	1.5	1.0	1.5
2N1490	T0-3	43	55	25	1.5	1.0	1.5
2N1618	TO-61	45	80	15	2.0	2.0	2.0
2N1722	T0-53	50	80	20	2.0	1.0	2.0
2N1724	T0-61	50	80	20	2.0	1.0	2.0
2N1768	T0-75	22.8	40	35	0.75	0.75	0.75
2N1769	T0-75	22.8	55	35	0.75	0.75	0.75
2N2033	T0-5	5.0	60	20	0.5	0.8	0.5
2N2034	T0-5	5.0	60	20	1.0	0.3	1.0
2N2035	T0-8	14.1	60	20	1.5	0.45	1.5
2N2036	T0-37	10	60	20	2.0	1.0	2.0
2N2823	T0-63	100	80	10	20	1.1	20
2N2824	T0-63	100	100	10	20	1.1	20
2N2825	T0-63	100	150	10	20	1.1	20
2N2828	T0-59	22.8	60	20	0.5	0.4	0.5
2N2829	T0-59	22.8	60	20	1.0	0.3	1.0
2N2858	T0-5	5.0	80	20	1.0	0.3	1.0
2N2859	T0-5	5.0	100	20	1.0	0.3	1.0
2N2911	T0-5	5.0	125	20	1.0	0.3	1.0
2N3149	11/16" stud	200	80	10	50	1.5	50
2N3150	11/16" stud	200	100	10	50	1.5	50
2N3151	11/16" stud	200	150	10	50	1.5	50
STC2500	11/4" stud	300	100	10	100	1.5	100
STC2501	11/4" stud	300	150	10	100	1.5	100

NPN Types

Туре	Case Type	Pd Watts 100°C Case	BVCEO Volts	hfe Min.	@ Ic Amps.	VCE(sat.) Volts Max.	@ Ic Amps.
2N3237	IND. TO-3	100	75	12	10	2.0	10
2N3238	IND. TO-3	85	80	8.5	10	3.0	10
2N3239	IND. TO-3	85	80	8.5	10	1.0	10
2N3240	IND. TO-3	85	160	8.5	10	1.0	10

PNP Types

Туре	Case Type	Pd Watts 100°C Case	BVCEO Volts	hfe Min.	@ Ic Amps.	VCE(sat.) Volts Max.	@ Ic Amps
2N2881	T0-5	5.0	60	20	0.5	0.4	0.5
2N2882	T0-5	5.0	100	20	0.5	0.4	0.5
2N3163	T0-61	45	40	12	1.0	0.75	1.0
2N3164	T0-61	45	60	12	1.0	0.75	1.0
2N3165	T0-61	45	80	12	1.0	0.75	1.0
2N3166	T0-61	45	100	12	1.0	0.75	1.0
2N3175	TO-61	45	40	10	2.0	1.0	2.0
2N3176	T0-61	45	60	10	2.0	1.0	2.0
2N3177	T0-61	45	80	10	2.0	1.0	2.0
2N3178	T0-61	45	100	10	2.0	1.0	2.0
2N3202	T0-5	5	40	20	1.0	0.3	1.0
2N3203	T0-5	5	60	20	1.0	0.3	1.0
2N3204	T-0-5	5	80	20	1.0	0.3	1.0
2N3205	T0-59	22.8	40	20	0.5	0.4	0.5
2N3206	T0-59	22.8	60	20	0.5	0.4	0.5
2N3207	T0-59	22.8	100	20	0.5	0.4	0.5
2N3208	T0-5	5.0	40	20	0.5	0.4	0.5

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May 17, 1966

Choosing ICs need not be a chore. Use

this directory of available circuits to eliminate those hours spent searching in vain.

As the number of available microelectronic circuits, and in particular integrated circuits (ICs), becomes greater and greater, the task of selecting the best circuit for a given application becomes correspondingly more difficult and time-consuming. By listing the available integrated circuits by major logic categories and a key parameter, Electronic Design's Microelectronic Data Charts will save you many hours of needless searching.

Data charts make selection easier

These data charts provide a method of comparing available standard devices within the limitation of manufacturers' available data. For convenience, the charts are separated into the following categories:

- Section 1—Diode Transistor Logic (DTL).
- Section 2—Direct-Coupled Transistor Logic (DCTL) and Resistor-Transistor Logic (RTL).
- Section 3—Transistor-Transistor Logic (TTL).
- Section 4—Emitter-Coupled Logic (ECL).
- Section 5—Resistor-Capacitor Transistor Logic (RCTL).
- Section 6—Complementary Transistor Logic (CTL).
- Section 7—Miscellaneous Digital Circuits
- Section 8—Linear Circuits

The attached table gives a fast run-down of the major parameters associated with digital circuits. As an example of circuit designs, a two-input NOR gate circuit is shown for each of the logic types. The parameter values given are based on typical values and serve only as a guide.

To further aid your search, the first three sections of the directory, because of their extreme length, also contain a dot chart listing of logic circuits and the names of the manufacturers making them.

The data charts are each divided into circuit sub-categories with headings such as Gates, Binary Elements, and Expanders for the digital circuits and Operational Amplifiers, Comparators, and Voltage Regulators for the linear circuits.

The listings are again divided up, especially for the gate circuits, into AND, NAND, NOR, etc., subgroups. Within any group or subgroup, the listings are in order of increasing propagation delays.

As is often the case, a particular model number may be known and it is the data listing that has to be found. The Cross-Reference Index, following Section Eight, provides a fast method for locating this information. The first column of the index lists all of the model numbers in an alpha-numerical sequence. The second column consists of a two or three digit listing which calls out the section, category and subgroup where the device is located. On the charts, these cross-references are listed in the first two columns. For example, suppose you wished to locate a device whose model number you know to be MC1114. The cross-reference listing is 1E1. In the first section (DTL), you would scan down the first column until you came to E (Gates). You then scan down the second column until you come to 1(AND). The device will be listed in this grouping.

The charts are only a guide to the most useful circuits for a particular application. Though they will help to bring some order to the immense problem of selecting and purchasing integrated circuits, a thorough check of manufacturers' data sheets is imperative.

Understanding the specs is a must

Before analyzing the data listings, an understanding of what the various parameters mean is helpful. Manufacturers use various test methods, and though their reasons for doing so are usually meaningful, the design engineer should be aware of these different methods and understand their meaning in relation to his particular application.

Propagation delay, loosely defined as the time required to transfer a pulse through the integrated circuit device, is one of the most important measures of circuit performance. Since different methods of testing this parameter exist, manufacturers' data sheets must include both a description of the test circuit and a full definition of the waveforms measured. In addition, data sheets should spell out switching times as well, and some indication should be made of variations in these

Typical IC characteristics and circuits

Symbol	Circuit diagram	Speed*	Power*	Fan-out*	Noise immunity*	Remarks
DCTL		Medium	Medium	Low	Low	Variations in input characteristics result in base-current "hogging" problem. Proper operation not always guaranteed. More susceptible to noise because of low operating and signal voltages.
RTL	0-W-V	Low	Low	Low	Low	Very similar to DCTL. Resistors resolve current "hogging" problem and reduce power dissipation. However, operating speed is affected and also reduced.
RCTL		Low	Low	Low	Low	Though capacitors can increase speed capability, noise immunity is affected by capacitive coupling of noise signals.
DTL	0 H H H	Medium	Medium	Medium	Medium to High	Use of pull-up resistor and charge-control technique improves speed capabilities. Many modifications of this circuit exist, each having specific advantages.
TTL		Medium	Medium	Medium	Medium to High	Very similar to DTL. Has lower parasitic capacity at inputs. With the many existing variations, this is becoming very popular.
CML	O-V	High	High	High	Medium to High	Similar to a differential amplifier, the reference voltage sets the threshold voltage. High-speed, high fan-out operation is possible with associated high power dissipation. Also known as emitter-coupled logic (ECL).
CTL	P+V O-V	High	High	Medium	Medium	More difficult manufacturing process results in compromises of active device characteristics and higher cost.
	*Legend Low = Medium = High =	<5 MHz 5 to 15 MHz >15 MHz	<5 mW 5 to 15 mW >15 mW	<5 5 to 10 >10	<300 mV 300 to 500 mV >500 mV	

May 17, 1966 171



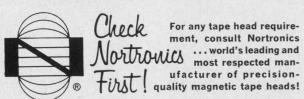


Mortronics pioneered their development for in-car and home cartridge players!

If you're designing a cartridge tape recorder or playback unit—take a good look at Nortronics' B2Q and B2L heads! These two popular 4-Track and 8-Track stereo heads lead the industry in acceptance, and offer:

- Outstanding shielding against external magnetic fields.
- Optimum high frequency resolution. Precision deposited quartz gaps, available from 50 to 500 micro-inches.
- Hyperbolic, highly polished, all-metal faces for intimate tape-to-gap contact and reduced oxide build up.

B2L: 8-Track Stereo Head; 20-mil tracks spaced 127-mils on centers. **B2Q:** 4-Track Stereo; 43-mil tracks spaced 136-mils on centers.





8185-C 10th Ave. No. . Minneapolis, Minnesota 55427

measurements as a function of loading (fan-out) and temperature.

Fan-in refers to the number of inputs that the device takes. A carry-over from older times, this rating, where given, many provide additional information to that given in the "Type" column in the data charts.

Fan-out is the measure of a circuit's capability to drive a specified number of the same circuit from its output. Though both typical and maximum values may be listed, only the latter value can realistically be used in making comparisons.

Power dissipation may be given per node, gate, stage, circuit, or package; or it may be given without any qualifications. Any reasonable comparison of this rating is greatly complicated by this lack of a standard. In the data charts, a slash following a power rating indicates a per-gate value, if in the gates section, and a per-stage value, if in the binary elements section. Note that the power dissipation is a function of the supply voltage and that it varies directly with operating speed; in looking at manufacturer's data sheets, check that all the test data are taken under the same operating conditions.

Noise margin or noise immunity indicates the minimum amount of noise voltage that will cause an "error" in the output of a logic circuit. Normally, noise immunity for a "0" logic state is defined as the difference between the minimum "0" input threshold and the maximum "0" output signal. For a "1" logic state, it is the difference between the minimum output signal and the maximum "1" input threshold. With logic errors possible in either of two available states, the noise immunity rating should be checked for both logical "0" and "1" conditions. Also, since supply voltage and loading conditions affect this circuit characteristic, only the worst-case measurement should be used.

Temperature ratings are for a -55°C to +125°C range unless otherwise noted.

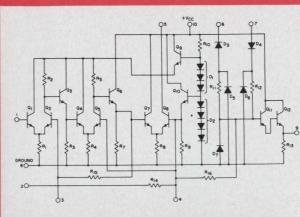
Package types for integrated circuits basically fall into three categories: the flat-pack, the tenlead TO-5, and the dual-in-line packages. Though a number of manufacturers have registered their particular package designs with the JEDEC Semiconductor Device Council (JEDEC Publication 12E) there are still no standards set in the industry. The data charts in this directory use a letter code for the various packages, as follows:

- A = TO-5
- B = TO-47
- C = 1/4 in. sq. flat-pack (TO-86, TO-91)
- $D = 1/4 \times 1/8$ in. flat-pack (TO-84, TO-85, TO-89, TO-90)
- $\mathbf{E} = 3/8$ in. sq. flat-pack
- $F = 1/4 \times 3/8$ in. flat-pack (TO-87, TO-88, TO-95)
- G = Special package (TO-69, TO-70, TO-71, TO-73 through TO-80, TO-96, TO-97, TO-99, TO-100, TO-101)

The numbers in parentheses refer to the JEDEC registered devices and are listed by their approximate size and style. • •

4 NEW LINEAR-ECONOMY-LINE RCA INTEGRATED CIRCUITS

...pack all of this

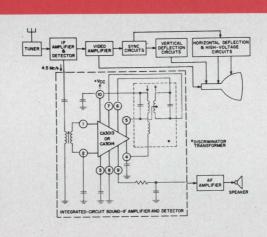


Exceptionally high amplifier gain

- Voltage Gain:
 67 dB typical @ 4.5 MHz
- Power Gain:75 dB typical @ 4.5 MHz
- Exceptional limiting characteristics
- Input Limiting Voltage (knee): 300 μ v @ 4.5 MHz typical

In TO-5 style package.

into applications like this...



excellent AM rejection
>>50 dB @ 4.5 MHz

Four functions on a monolithic chip:

- IF Amplifier
- AM and Noise Limiter
- FM Detector
- Audio Preamplifier

...at prices as low as \$200 (single unit price)

NEW ECONOMY AND PERFORMANCE FOR TV/FM/INSTRUMENTATION FROM 100 KHz TO > 20 MHz

Now four new RCA linear types make integrated circuits a working reality for a broad spectrum of communications and instrumentation applications. Here are all the economy, performance, and reliability advantages you've been waiting for, in practical, low-cost linear circuits.

Included in this new RCA linear-economy-line, are:

CA3011 Wideband Amplifier—up to 7.5v supply*

CA3012 Wideband Amplifier—up to 10v supply*

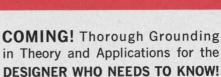
CA3013 Wideband Amplifier-Discriminator—up to 7.5v supply*

CA3014 Wideband Amplifier-Discriminator—up to 10v supply*

*suggested maximum V_{CC}

All four circuits are available now for your design and evaluation requirements. For price and delivery information, call your RCA Field Representative today. For technical data, write Commercial Engineering, Section IC-G-5-3, RCA Electronic Components and Devices, Harrison, N.J. 07029.

†CA3011 \$2.00 (single-unit price)





CHECK RCA'S VERSATILE LINEAR LINE FOR:

Туре	CA3000	CA3001	CA3002	CA3004 CA3005 CA3006	CA3007	CA3008 CA3010
Function	VIDEO AMPL.	DC AMPL.	IF AMPL.	RF AMPLS.	AF AMPL.	OPERATIONAL AMPLS.
Gain dB	37 @ 1 KHz	19 @ 1 MHz	24.4 @ 1.75 MHz	12-16 @ 100 MHz	22 @ 1 KHz	60 @ 1 KHz
—3dB Bandwidth	650 KHz	16 MHz	11 MHz	100 MHz	20 KHz	300 KHz

Available through your RCA distributor

The Most Trusted Name in Electronics

1. Diode-Transistor Logic

	Logic Function	Туре	Model	Mfr.	Propaga- tion Delay (ns)	-	n-in Max.	Fan Typ.	-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Lev (Vol	els	Noise Margin (mV)	Temp Range (°C)	Package Type	3 Remarks
Adders A		Half Half	A51 UC1004B	SI SPR	35 40	-	-	-	5 5	40 130	5 6,-3	1.1	2.7 5.8	700 500	0 to 70	A, D	
Binary Elements B		R-S Flip Flop R-S Flip Flop R-S Flip Flop Counter Flip-Flop R-S Flip-Flop	RD - 208 RD-308 RD-508 NC/PC8 NC/PC12 PC-13 8200 UC1002B MC282G DTµL950 ND1003	RAD RAD GI GI VAR SPR MO FA NA	7 7 7 8 8 8 8 10 14 18 20 20		- 4 4 - 1 - - - 2 2	- - - - 2	7 4 7 5 22 5 4 5 - 12	20 20 20 200 - 200 100 65 7.5 40 20	5 5 12, 4.2 12, 4.2 12, 4.2 6, 3 6,-3 - 5.0 6	.250 0.25 0.25 0 0 0 0.5 0.4 -	4.5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	800 800 800 500 550 600 750		D D D A A E E E A A C A C	Expandable Expandable MC¹RCDT MC RCDT TF
		J-K Flip Flop J-K Flip Flop R-S R-S - R-S R-S Shift Reg.	RD-207 RD-307 RD-507 SW201 SW212 WM202 WM212 RC202T RC212T A09	RAD RAD SW SW WH WH RA RA SI	20 20 20 20 20 23 23 32 32 32(0 to 1) 52(1 to 0)	- - - 3 3 - -	3 3	- - - - - 10 10	12 8 12 10 10 10 10 - - 5	95 95 95 7 7 15 15 9.5 9.5 9.5	5556666665	0.25 0.25 0.25 0.35 0.35 0.35 - - 1.0	3 3 2.0 2.0 2.0 2.0 - - 2.7	800 800 550 550 550 550 550 550 900	0+75 - - - - - -	D D C, D D A, C, D A, D A, D A, D A, D	And Expand.
		Shift-Reg	A49	SI	32(0-1) 52(1-0)	-	-	-	5	54	5	1.1	2.7	700	0 to 70	A, D	
		R-S, J-K Clocked R-S, J-K R-S, J-K Clocked R-S, J-K R-S, J-K Shift Reg.	DTµL948 MC831 MC848 MC931 MC948 A03	FA MO MO MO MO SI	40 40 40 40 40 40(0 to 1)	11111	2	11111	12 7 11 7 9 5	45 20 45 20 45 45 40	5.0 5 5 5 5	0.2 0.2 0.2 0.2 0.2 1.0	5 5 5 5 2.7	500 500 500 500 500 900	0 to 75 0 to 75 0 to 75	A, C A, C A, C A, C A, D	Modified DTL Modified DTL Modified DTL Modified DTL
		Shift Reg	A43	SI	60(1 to 0) 40(0-1) 60(1-0)	-	-	-	5	40	5	1.1	2.7	700	0 to 70	A, D	
		R-S J-K R-S J-K R-S J-K R-S J-K R-S J-K Clocked J-K/R-S Pulse Triggered J-K/R-S Pulse Triggered Clocked JK-RS R-S, J-K R-S, J-K Clocked J-K R-S Clocked J-K R-S L-K R-S J-K R-	S1948 S1948 D SW931 SW931 SW948 SN15848 SN15850 SN15948 SN15950 DT \$\mu\$-931 DT \$\mu\$-1295 MC209 MC845 MC945 PL931 S1931 S1931 S1931 S1945 SN15931 SN1593 SN159 SN1	SI S	40 40 40 45 45 45 50 50 50 50 50 50 50 50 50 50 60 60 60 60 60	2	2 2 2 2 2 2	888111111111991111111111	12 12 10 - 9 8 9 8 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	45 45 46 48 35 - 20 35 16 35 35 20 20 20 20 20 20 30 40 16 20 30 40 40 16 20 30 40 40 40 40 40 40 40 40 40 40 40 40 40	5 5 4 to 6 4.5 - 5.5 5 4.5 - 5.5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	0.2 0.2 0.6 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	5.0 3.0 6.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1	600 600 1000 750 750 750 500 600 500 500 500 500 600 1000 750 750 1000 1000 1000 1000	-25 to +12: 0 to 75 0 -75 0 -75 0 to 75 - 0 to 75 - 0 to 75 - 0 to 75 - 0 to 75 0 to 75	D A - D, D D A, A, A, A, C C D D D D D D D D D D D D D D D D D	Modified DTL Modified DTL
		J-K Dual J-K Dual J-K	SN5301 SN5302 SN5304	TI TI TI	60 60 60	1 1 1		-	10 10 10	27 27 27 / ff	3-4 3-4 3-4		1 11 1	300 300 300	- -	D D D	Preset & Clear Preset Preset & Clear

¹⁾ See pages 4-9 for manufacturer's name. 2) -55° to $+125^{\circ}$ C unless otherwise indicated. 3) MC= Multiple Chip; TF= Thin-film hybrid.

					Propaga- tion	Far	ı-in	Fan	-out		Supply	Lev (Yo	els	Noise Margin	Temp Range	9	
	Logic Function	Туре	Model	Mfr!	Delay (ns)	Тур.	Max.	Тур.	Max.		Voltage (Volts)	0,,	"1"	(mV)	(°C)	Package Type	Remarks
В		J-K J-K Dual J-K Dual J-K	SN7301 SN7300 SN7302 SN7304	TI TI TI	60 60 60 60				10 10 10 10	27 27 27/ft 27/ft			1111	300	0-70 0-70 0-70 0-70	D D D	Preset and Clear Preset Preset Preset and
	J-K Counter JK Pulse J-K J-K D-K J-K A to D D to A	J-K Counter JK Pulse - J-K	RC203T WM215 WM203 RC215T RC213T WM213 WM503 NC/PC19 WM225G	RA WH WH RA RA WH	†5MHz †5MHz †5MHz †5MHz †11MHz †12MHz †20MHz			4 - - 9 8 - 10 -	- 9 4 - 9 - 5 10	75 45 84 56 40 35 47 200 55	6 6.0 6 6 6 6 6 4.5 12, 4.2 6	- 0.35 0.35 - 0.35 0.40 0	- 2.0 2.0 - 2.0 1.8 5	550 550 550 550 - 550 500 - 550	0 to 125	A, D, D A, C, D A, D A, D A, C, D D A, E D	clear †clock rate †fT †fclock rate †clock rate †clock rate †ft ft
Converters C			WS815 WS150	WH WH	-	-	-	-	5	60 100	20, 4.0 10, 6.4	0.45 0.45	1.75 1.75	250 250	0 to 125 0 to 125	CC	
Drivers / Buffers D		Dual 4-input Dual 4-input Jual 4-input Jual 4-input Jual Dual Dual 8-input Dual 4-input Dual 4-input Dual 4-input Dual 4-input Jual 4-input Jual 4-input Dual 4-input	RD -209 RD-309 RD-509 UC1003B 8213 WM510 SE155 WM234G DT ₂ L-932 MC932 PL 932 S1932 CS715 SE157 SW932 SW944 SN5832	RADD RADD SPR WH SIG SIG WH FA MO MO PH SI SI SIG SIG SW SW TI	7	- - - 5 - - - - - - 100 100	4 4 4 15 5 4 4 4 - - - 4 4 2 3 3 - -	- - - - - - - - - - - - - - - - - - -	12 8 12 15 10 - 19 19 16 25 25 25 25 25 25 19 19	22 22 22 55 - 20 30 30 30 30 30 30 30 30 30 30 30 30 30	5 5 6, -3 6, -3 4, 5 +4 +4 +4 6 5 5 5 5 5 5 4, -2 4, -2 4, -6 4, 5 -5, -5, 5	0.25 0.25 0.25 0.40 0.5 0.40 0.4 2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.4 0.4 0.4	3 3 5.8 3.5 1.8 3.9 3.9 1 5 5 5 4.0 5 5 5 3.9 2.6 2.6	800 800 800 500 500 1000 1000 550 500 500 750 750 1000 100		D D D D T T D F F D A, A, C, D D A A T T D	Expandable Expandable TF Expandable Modified DTL Modified DTL Expandable
		Dual 4 - input	SN15932	TI	25	-	-	-	20	15/ gate	4.5 - 5.5	-	-	750	-	D	
		Quad Inverter/ Driver Quad Dual	SN535 SN7350 RC210T RC210Q RC210G	TI TI RA	30 30 32			- - 11	10	9/ gate 9/inv 9.5/ gate	3-4	- - -		300 _ 550	0-70 -	D, J A, D	Modified DTL
			ND1002 WM210 SE750 WS817 WS817Q MC205 MC255 WS816 SN343A SN346A	NA WH SIG WH WH MO MO WH TI TI	35 37 40 50 50 55 55 55 80 500 850	3	2 3 2 3 3 4	20 - - 25 - - - 10 -	- 22 20 - 25 20 20 - 13 11	20 60 36 20 15 50 50 60 25 160	6 6 +4,-2 4.0 4.0 6, -6 4 4.0 24, 6-3	0.2 0.35 0.4 0.45 0.7 0.6 - 0.45 -	4.0 2.0 3-9 1.75 1.75 2.5 - 1.75	300	0 to 125 0-125 0-125 0 to 75 0 to 125 0 to 65 0 to 65	- A, C C C A, C C D D A, D	1000 ohm Load Minuteman Minuteman Type
	AND	Dual	A60	SI		-	4	-	=	7	5 5	1.1	2.7	700	0 to 70	A, D	
Gates E	AND 1		MC203 8207 8208 8209 8210 MC1111 MC1112 MC1113 MC11114 MC215 MC253 MC265 CS705	MO VAR VAR VAR MO MO MO MO MO MO SIG	4 10 10 10 10 10 15 15 15 15 1- -	6 - - 3-4 2,2,2 2,1 8 - -	- - - - - 1, 1	666661111111	- 10 10 10 10 10 6	100 - - - 200 300 300 100 - - 5	6, 8 6 6 6 10 10 10 10 - - +4, 2	0.6 - - - - - - - 4 4 4 0.4	2.0 - - - - - - .3 .3 .3 .3,.9	500 - - - - - - - - - - - - - - - - - -		A, C	TF, Expand. TF, Expand. TF, Expand. TF, Expand.

May 17, 1966 175

¹⁾ See pages 4-9 for manufacturer's name. 2) -55° to $+125^{\circ}$ C unless otherwise indicated. 3) MC= Multiple Chip; TF= Thin-film hybrid.

	Logic Function	Туре	Model	Mfr.	Propaga- tion Delay (ns)	-	n-in Max.	Fan	-out	Power Diss. (mW)	Supply Voltage (Volts)	Le	gic vels olts)	Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks 3
E	AND/NAND	-	WS813Q	WH	50	-	2	10	-	20	4.0	0.7	1.75	250	0 to 125	С	
	AND/OR 2	5-input Dual	SN532 SN534	TI TI	5 5	-	-	-	4 4	10	3-4	-	_	300 300	-	D D	Modified DTL Modified DTL
		- - -	WS810Q WS812Q WS814Q	WH WH WH	50 50 50		2 3 2	10 10 10		gate 20 15 20	4.0 4.0 4.0	0.7 0.7 0.7	1.75 1.75 1.75	250 250 250	0 to 125 0 to 125 0 to 125	CCC	
	NAND 3	_	NC-11 PC-11	GI GI	8	-	4 6	-	5 5	60	12, 4.2, 12, 4.2,	0 0	5 5	=	-	A E	MC RCDT MC RCDT
		Dual	PC-15	GI	8	-	3+3	-	5	60	-3 12, 4.2	0	5	-	-	E	MC RCDT
		Dual Triple Dual Triple - Dual	8214 WM506 SWA05 WM556 UC1001B SW708	VAR WH SW WH SPR SW	10 10 12 12 15 15	5 3 - 3 20 4	15 3 4 3 15 10	2 10 - 12 8 10	4 - 10 - 4 15	50 57 15 30 30 15	-3 6, 3, -3 4.5 5 4.5 6,-3 4 to 6	0.5 0.40 0.8 0.40 0.4 0.3	3.5 1.8 4.8 1.8 5.0 3.0	500 900 500 500 1000		D A D - A	TF
		Dual	SW930 SW401 SW402 WM236G WM236G WM241G WM296G PL930 PL946 SW101 SW204 SW201 SW204 SW211 SW224 SW231 SW224 SW231 SW946 SW962 WM211 WM216 WM211 WM216 WM216 SW962 SW962 SW962 SW962 SW962 SW962 SW962 SW962 SW962 SW962 SW962 SW962 SW962 SW962 SW962 SW962 SW963 SW964 SW962 SW962 SW962 SW962 SW962 SW963 SW964 SW	SW SW WH WH WH PPH SW SW SW SW SW SW SW SW TW WH WH WH WH WH TRA RA RA RA RA RA TI TI TI TI TI TI TI TI TI	17 18 18 19 19 19 19 19 20 20 20 20 20 20 20 20 20 20 20 20 20	4 4 - 4 3 4 - 3 8 8 4 50 2 3 3 3 3 4 2 4 2, 3 4 4 6 8	10 4 4 4 4 6 8 8 4 6 8 8		8 15 15 16 16 16 16 16 16 16 18 8 7 7 7 7 11 11 11 11 11 11 11 11 11 11 1	5777759593393117446666677777777777777777777777777777	4 to 6 5 5 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	0.3 0.8 0.8 2 2 2 2 2 2 0.2 0.2 0.6 0.6 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35	3.00 2.5 2.5 1 1 1 4.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00	1000 900 900 550 550 550 550 550 550 550		C AAADDDDDCCAAAAAAADIIIADADADDIIID D D D D AAAA	& Expandable And Expand. And Expandable Expandable Expandable And Expand. And Expand. And Expand. And Expand. And Expand. Expandable Expandable

¹⁾ See pages 4-9 for manufacturer's name. 2) -55° to $+125^{\circ}$ C unless otherwise indicated. 3) MC= Multiple Chip; TF= Thin-film hybrid.

Logic Function	Туре	Model	Mfr.1	Propaga- tion Delay (ns)	Fai	n-in Max.	Fan Typ.		Power Diss. (mW)	Supply Voltage (Volts)	Log Lev (Vol	els	Noise Margin (mV)	Temp Range (°C)	Package Type	3 Remarks
3	Dual 4 input Dual 3-input Dual 4-input Quad 2-input Sextuple Triple 3-input 4-input 6-input 8-input Dual	RC211T RC221T RC231G WM246G WM286G RC206G RC216G RC204T RC214T RC224T WS811Q	RA RA WH WH RA RA RA WH	30 30 30 30 30 32 32 35 35 35 35		- - - - - - - 3	11 11 11 - - 11 11 11 11 11	- - 11 11 - - - -	9.5 9.5 9.5 38 57 9.5 9.5 9.5 9.5	6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	- - 2 2 2 - - - - 0.7	- - 1 1 - - - - 1.75	55 0 55 0 55 0 55 0 55 0 55 0 55 0 55 0	- - - - - - - - 0 to 125	A, D A, D D D D D D A, D A, D C	
NAND/NOR 4	Triple 3 - input Quad 2 - input Dual 4 - input Triple 3 - input Quad 2 - input Dual 4 - input Triple 3 - input Quad 2 - input Quad 2 - input Quad 2 - input Quad 2 - input Quad 1 - input Quad Inverter Dual	RD - 205 RD - 206 RD - 210 RD - 305 RD - 305 RD - 306 RD - 506 RD - 507 A10 A12 A13 A45 A50 A62 A02 A06 A07 A14 A15 A41 A42 A46 A47 A53 A54 A55 SE111 SE113 CS700 CS721 CS727 CS730 SE112 SE170 SE180 DTµL946 DTµL946 DTµL946 DTµL946 DTµL946 MC830 MC846	MO SI SI SI SI SI SI SI SI SI SI SI SI SI	7 7 7		3 2 4 1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4		8 8 8 8 5 5 5 5 8 8 8 8 5 5 5 5 10 10 5 5 4 - 15 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	10 10 10 10 10 10 10 10 10 10 10 10 11 15 15 15 15 15 15 15 15 7,7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	55555555555555555555555555555555555555	0.25 0.25 0.250 0.25 0.250 0.25 0.250 0.25 0.25	5 5 5 5 5 5 4.5 5 4.5 5 5 5 5 6.84 4.5 7 2.7 2.7 2.7 2.7 2.7 2.7 2.7 2.7 2.7 2	800 800 800 800 800 800 800 800 800		DDDDDDDDA,A,IIIA,A,A,IAIA,A,A,A,DDA,A,A,A,	Expandable Line Driver Expandable Expandable Expandable W/expander W/expander Expandable Expandable Expandable Expandable Modified DTL Expandable Modified DTL
	Triple 3-input	MC862	MO	25	-	-	-	8	5	5	0.2	5	500	0 to 75	C	Expandable Modified DTL
	Dual 4-input	MC930	MO	25	-	-	-	8	5	5	0.2	5	500	-	A, C	Expandable Modified DTL Expandable

May 17, 1966 177

See pages 4-9 for manufacturer's name.
 -55° to +125°C unless otherwise indicated.
 MC= Multiple Chip; TF= Thin-film hybrid.

					Propaga- tion Delay	Fa	n-in	Fan	-out	Power Diss.	Supply Voltage	Lev (Vo	els	Noise Margin	Temp Range	Package	3
	Logic Function	Туре	Model	Mfr.	(ns)	Тур.	Max.	Тур.	Max.		(Volts)	"0"	"]"	(mV)	(°C)	Туре	Remarks
E	4	Quad 2-input	MC946	MO	25	-	-	-	8	5	5	0.2	5	500	-	С	Modified DT Expandable
		Triple 3-input	MC962	МО	25	-	-	-	8	5	5	0.2	5	500	-	С	Modified DT Expandable
		Dual 4-input Dual 4-input Quad Quad Triple Triple Single Single Dual Dual Dual Dual Dual 3-input 4-input 3-input Dual 2-input Dual 3-input	\$1930 \$19300 \$1946 \$1946 \$1946D \$1962D \$E101 \$E102 \$E115 MC201 MC206 MC207 MC208 MC212 MC213 MC251 MC251 MC252 MC256 MC257 MC258 MC258 MC258 MC263 SN531 SN531 SN531	SI S	25 25 25 25 25 25 25 25 25 25 25 30 30 30 30 30 30 30 30 30 30 30 30 30	4 3 2-2	8 8 8 2 2 3 3 3 4 3 2 2 2 - 3 3 - 3 3 - 3 3 - 3 3 - 3 -		8 8 8 8 8 8 5 5 5 5 5 5 5 5 5 5 5 5 5 5	5 5 5 5 5 5 5 5 5 6 6 6 12 12 30 12 30 12 30 12 30 11 12 30 11 12 30 10 11 10 10 10 10 10 10 10 10 10 10 10	5 5 5 5 5 5 5 5 5 5 5 5 5 5 7 8, -8 8, -8 8, -8 4 4 4 4 4 4 4 4 4 4 4 4 4 4 3 5 6 6 7 7 8 7 8 7 8 8 7 8 8 7 8 8 7 8 8 7 8 8 7 8 8 7 8 8 8 8 7 8 8 8 8 7 8	0.2 0.2 0.2 0.2 0.2 0.4 0.4 0.6 0.6 4 4 4 4 4 4 4 4 4 4	5.00 5.00 5.50 5.50 5.50 5.50 5.50 5.50	750 750 750 750 750 750 750 750 1000 100	0 to 75 - 0 to 75 - 0 to 75	D D D D D A A A A A A A A A A A A A A A	Modified DTI Modified DTI Modified DTI
		Triple 3 - input	SN5331	TI	30	_		-	10	gate 10/	3-4	-	_	300	-	D	Modified DTL
		Quad 2 - input	SN5360	TI	30	_ 1	-	_	10	gate 10/	3-4	-	_	300	_	D	Modified DTI
		5-input Dual 5-input	SN7310 SN7311	TI TI	30 30	_	-	-	10 10	gate 10 10/	3-4 3-4	- -		=	0-70 0-70	D D	Expandable
		Dual 3-input	SN7330	TI	30	-	-	-	10	gate 10/	3-4	-	-	_	0-70	D	
		Triple 3-input	SN7331	TI	30	-	-	-	10	gate 10/	3-4	-	-	-	0-70	D	
		Quad 2-input	SN7360	TI	30	-	-	-	10	gate 10/	3-4	-	-	-	0-70	D	
		Single 3-input Dual Dual Dual 3-input Dual 4-input	SE110 MC254 SI944 SI944D MC650G MC651F	SIG MO SI SI MO MO	35 40 40 40 50 50	3 - - -	3 - 4 4 4 5	1 1 1 1 1	20 20 27 27 5 5	gate 36 30 20 20 180 180	+4,-2 4 - 10 10	0.4 4 0.2 0.2 9.7 9.7	3.9 .3 5 .70 .70	1000 500 750 750 5V 5V	0 to 75 0 to 75 0 to 75 0 to 75 0 to 75	A, C A, C D D A C	Modified DTL Modified DTL
	NOR	-	NC-10	GI	8	-	4	-	5	170	12, 4.2,	0	5	-	-	A	MC RCDT
	5	-	PC-10	GI	8		6	-	15	170	-3 12, 4.2,	0	5	-	-	E	MC RCDT
		Dual	PC-14	GI	8	-	3+3	-	5	170	-3 12, 4.2, -3	0	5	Ī	-	Ł	MC RCDT
		-	8204	VAR	10-15	-	9	3	4	100	6,3	0.5	3.5	-	_	-	TF
	Exclusive – OR	Dual 4-input Dual 4-input Dual 4-input Dual 4-input Dual	ND1006 DT ₁ L944 MC204 MC844 MC944 SN5370	NA FA MO MO MO TI	35 40 40 40 40 90	- 3 - -	3 4 - - -	10	27 20 27 27 27 10	20 20 40 20 20 20/ gate	6 5.0 6, -6 5 3 - 4	0.2 0.2 0.6 0.2 0.2	4.0 5 2.5 5 5	750 750 500 500 500 500 300	- - 0 to 75 -	A, C A, C A, C A, C D	Modified DTL Modified DTL Modified DTL
		Dual	SN7370	TI	90	-	-		10	20/ gate	3-4	-	-	-	0-70	D	
Expanders F		_	RC226 RC246 A04	RA RA SI	2 2 4	2,3	6 6				-				-	– – A, D	Diode Array

¹⁾ See pages 4-9 for manufacturer's name. 2) -55° to $+125^{\circ}$ C unless otherwise indicated. 3) MC= Multiple Chip; TF= Thin-film hybrid.

	Logic Function	Туре	Model	Mfr.¹	Propaga- tion Delay (ns)	Fan	-in Max.	Fan	-out	Diss.	Supply Voltage (Volts)	Log Leve (Vol	els	Noise Margin (mV)	Temp Range (°C)	Package Type	3 Remarks
F		5-input Dual 4-input Dual Quad Single 6-input Dual - Dual 4-input Dual 4-input Dual Tiple	A44 SWA04 SN7320 DT ₁ L933 MC933 PL933 RD-111 RD-711 RD-711 S1933 S1933 D CS703 SE105 SE105 SE105 SE105 SUC1005B UC1005B UC1006B SW933 SN1583 SN1583 SN1583 SN15933 SW1217 WM227	SI SW TI FA MO MO PH RAD SI SIG SIG SIG SPR SPR SPR SPR ST TI WH WH	4 4 5 5		6 6 7 4 4 4 4 4 4 4 5 7 11			10			4.0		0-70 - 0 to 75 	A, D A, C A, C A, C D D A, C F A, C F A, C F A, C D D A, C F D D A, C D D D D D D D D D D D D D	Diode Array Diode Array Modified DTL Modified DTL Expandable Expandable Diode Array Diode Array
Inverters G		Quad Dual	SE181 MC1115	SIG MO	20 Toff=45 Ton=20	-	1	-	6 -	20 250	+4	0.4	3.9	1000	Ξ	A	
Logic Amplifie		-	8201 8202	VAR VAR	10	1 2	-	4 8	-	50 100	6, 3, 6, 3, 6, 3, 6	3 0.5	3.5 3.5	-	Ξ	Ξ	TF TF
Multivibrators I	7	Single-shot Single - shot 2-input Single - shot	NC/PC16 PC-18 DTµL951 A08 A48 8203 SN15851 SN15951 SN5380 SN7380 SE160 SE161	GI GI FA SI SI VAF TI TI TI TI SIG SIG	8 8 25 30 30 30 50 50 100 100		- - 1 1 - - - 2 1	- - - 2 - - -	5 5 10 5 5 4 - 10 10 4 4	200 200 35 42 42 100 - 30 30 25 25	12, 4.1 5.0 5	2 0 0.2 1.0 1.1 0.5 .5 - - -	5 5 5 2.7 2.7 3.5 - - 3.9 3.9	 950 900 700 750 750 300 1000 1000		A, E E A, C A, D A, D D D D D A, C A, F	MC RCDT MC RCDT TF Modified DTL
Shift Bit J		_	RC205T WM205	RA WH	200 †4	-	-	4 -	- 4	75 84	6 6.0	0.3	2.0	0.55 550	0 to 125	Ā, C	†f _T

Who makes what in DTL

									Gates								
Manufacturer	Symbol	Adders	Binary Elements	Converters	Drivers/ Buffers	AND	AND/NAND	AND/OR	NAND	NAND/NOR	NOR	Exclusive- OR	Gate Expanders	Inverters	Logic Amplifiers	Multi- vibrators	Shift Bit
Fairchild	FA		•		•					•		•	•			•	
General Instrument	GI		•						•		•					•	
Motorola	MO		•		•	•				•		•	•	•			
National Semiconductor	NA		•		•							•					
Philco	PH		•		•				•				•				
Radiation	RAD		•		•					•			•				
Raytheon	RA		•		•				•				•				•
Signetics	SIG		•		•	•				•			•	•		•	
Siliconix	SI	•	•		•					•			•			•	
Sprague	SPR	•	•		•			ALL:	•	•			•	Jan Jan			
Stewart-Warner	SW		•		•				•				•				
Texas Instruments	TI		•		•			•	•	•		•				•	
Varo	VAR		•		•	•			•		•				•		
Westinghouse	WH																

2. Direct-Coupled Transistor Logic

													N. A.	2			
	Logic Function	Туре	Model	1 Mfr.	Propaga- tion Delay (ns)	Fan	-	Fan- Typ.		Power Diss. (mW)	Supply Voltage (Volts)	Log Leve (Vol	els	Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks 3
Adders A		Full Full Full Full Full Half Half Half Half Half Half Half Ha	μL-904 MC908G PL-908 MWμL-908 MC708G MC804G MC904G PL-904 H11001 H11004 A11 MC912G SN1734 PL-912 MW _μ L-912 MW _μ L-912 MC704G MC712G SN1729	FA MO PH NA AL AL SI MO TI PH FA MO TI	14 60 80 90 - 14 14 14 17 22 22 35 66 70/105 80 90 - 70/105	2 2	2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 -	4,5	5 4 4 4 4 5 5 5 5 4 4 4 4 16 4 3	45 10 10 10 3 45 45 45 45 42 42 40 8 8 8 8 8 20 3	33 33 33 33 33 35 33 33 36 66 66 3.3	0.15 0.9 0.220 0.9 1.1 1.1 0.18 0.12 0.12 0.9 - 0 0.220 1.1 0.9	0.1 0.1 0.8 1.2 1.1 1.1 0.1 - 0.8	- - 300 - 900 - 150		A A - B B A, D A A, D - A, C A	
Binary Elements B		Flip-Flop Flip-Flop Flip-Flop - J-K Toggle J-K J-K J-K J-K J-K J-K J-K J-K	MC702G μL902 MC802G MC902G PL902 PL916 NB1002 MC723G FμL916 MC726G FF1514B MC816G MC916G MC926G MC720G MC720G MC813G MC913G MC913G MC913G MC913G A17	FA MO	10 14 14 14 14 14 20 22 25 40 40 40 50 50 60 70 70 70 100 150 3000 5000 5000		2 1 2 2 - 1 4 3 3 2 5 5 1 4 4 4 5 5 5 5 4 4 4 1 1 4 - 5 5 1 1 1	4	13 4 4 4 4 4 4 3 -10 10 3 16 6 6 3 3 3 5 5 5 2 2 4 2 5 4 2 5 4 2 5 4 2 5 5 5 5	22 28 28 22 54 22 54 54 54 56 56 56 - - 12 15 15 15 15 15 15 15 15 15 16 18 18 18 18 18 18 18 18 18 18 18 18 18	7 max	1.1 0.21 1.5 1.1 0 0 0 - 1.1 0.15 0.15 1.1 1.1 0.2 1.1 1.1 0.9 0.9 0.9 0.9 0.65 0.65	0.1 1.0 0.1 0.8 0.8 - 0.1 1.0 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	250 - - -	15 to 55 0 to 100 15 to 55 15 to 55 0 to 100 15 to 55 15 to 55	A A A A A A A A A A A A A A A A A A A	†μ ν †μν †μν †μν
Buffers C			NB1000 B11004 BC11001 MC800G MC900G PL900 FμL9002S μL900 MC909G SN1730 MWμL909 PL909 MC700G MC709G	NA AL AL MO MO PH FA MO TI FA PH MO MO	8 15 15 15 15 15 16 16 16 57 70 80 80	1 1 1	1 6 2 - 4	5, 28	- 25 25 25 25 80 25 30 30 30 30 30 30	45 30 30 24 24 30 20 30 10 15 10 10 20	3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	0.18 0.12 0.12 1.3 1.3 0 0.15 1.1 - 0.220 0 1.3 1.1	1.2 1.1 1.1 0.1 0.8 1.0 0.1 0.1 0.80 0.1 0.80	300 300 250 150 5 350 -	70 0 to 100 - 15 to 55 - - - +15 to 55 15 to 55	A, C A A, D A, C	Modified DCTL
Counter Adapter D	s		NB1001 MC801G MC901G PL901 C11001 C11004 MC701G	NA MO MO PH AL AL MO	21 22 22 22 22 28 28 28	- - 2 - -	1	5	5 5 25 - 16	55 55 55 55 50 50 20	3 3 3 3 3 3.6	0.18 1.3 1.3 0 0.12 0.12 1.3	1.2 0.1 0.1 0.8 1.1 1.1 0.1	300	- 0 to 100 - - - 70 15 to 55	- A A - B B A	
Gates E	NAND/NOR 1	3-input 2-input Dual 3-input 3-input 4-input Dual 2-input Dual 3-input	FμL90329 FμL9142 FμL9152 MC703G MC707G MC714G MC715G	9 FA 9 FA	10 10 10 10 10 10 10	11111111	3 3 3 4 2 3	111111	16 16 16 16 16 16 16	20 20 20 - - -	3.6 3.6 3.6 3.6 3.6 3.6 3.6	0.25 0.25 0.25 1.1 1.1 1.1	0.86 0.86 0.86 0.1 0.1 0.1	300	15 to 55 15 to 55 15 to 55 15 to 55 15 to 55 15 to 55 15 to 55	A, C A, C A, C A A A	

See pages 4-9 for manufacturer's name.
 -55° to +125°C unless otherwise indicated.
 MC= Multiple Chip; TF= Thin-film hybrid.

DCTL and RTL (continued)

					Propaga-					Pawar	Sl.	Leve	ls	Noise	Temp 2		
	Logic Function	Туре	Model	Mfr.	Delay (ns)	Far Typ.	Max.	Fan-	Max.	Diss.	Supply Voltage (Volts)	(Vol	"]"	Margin (mV)	Range (°C)	Package Type	Remarks 3
E	1	5 input 5-input 4-input 4-input 3-input 3-input Dual 2-input Dual 3-input Dual 3-input 3-input 3-input 3-input 3-input 3-input 3-input 3-input 4-input Dual 3-input 3-input 4-input Dual 3-input 13-input	G11001 G11004 J11001 J11001 J11004 K11001 L11004 M11001 M11004 M2903 M2914 M2913 M2815G M2903G M2914G M2915G M2914G M2915G M2914G M2915G M2914G M2915G M2914G M2916G M2914G M2916G M2914G M2914	9 FA MO MO MO MO MO	12 12 12 12 12 12 12 12 12 12 12 12 12 1					10 10 10 10 10 10 20 20 20 20 22 24 24 27 27 54 54 27 27 27 27 27 27 27 27 27 27 27 27 27	3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	0.12 0.15 0.25 0.25 0.29 0.9 0.9 0.9 0.9 0.9 0.9	1.1		70	BBBBBBBAA,A,A,AAAAAAAAAAAAAAAAAAAAAAAA	
		4-input 4-input Dual 2-input 4-input Dual 2-input 4-input	SN1733 MC911G PL910 PL911 MWμL910 MWμL911		35/70 40 40 40 45 80	- 2 4 -	- 4 - - 2 4		4 4 4 4 4 4	gate 4 4 4 4 4 4	3 3 3 3 3 3	- 0.9 - 0.15 0.15	- 0.1 0.8 0.8 1.0 1.0	150 250 - 350 350		A, D A - - A, C A, C	
	NOR 2	3-input 4-input Dual 2-input Dual 3-input 4-input Dual 3-input Dual -	NB1003 NB1007 NB1014 NB1015 μL907 μ7095 RC323 RC103	NA NA NA FA PH RA RA	11 11 11 11 12 13 18 20		3 4 2,2 3,3 4 - -	5 5 5 5 - 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	- - - 5 5 - -	19 19 38 38 12 3 4 15	3 3 3 3-6 3 3	0.18 0.18 0.18 0.18 0.15 0.2 	1.2 1.2 1.2 1.2 1.0 1.0 - 1.0- 3.0 1.0-	300 300 300 300 250 300 300 300 300		- - - A, C A A, D	
		Dual	RC124	RA	20	2, 3	-	2, 5	-	2,15	3	0.15	3.0	300	-	-	
		Dual	RC144	RA	20	2, 3	-	2, 5	_	2, 15	3	0.15	3.0	300	-	-	
		-	RC1033	RA	20	3	-	5	-	15	3	0.2	3.0	300	-	-	
		-	RC1233	RA	20	3	-	5	-	15	3	0.15		300	-	-	
		Dual	RC-1243	RA	20	2, 3	-	2, 5	-	2, 15	3	0.2	3.0	300	-	-	
		Dual	RC1443	RA	20	2, 3	-	2, 5	-	2, 15	3	0.2	3.0	300	-	-	
		_ Dual	RC401 RC322	RA RA	23.5 25	2, 2	-	4 2, 5	-	3.5 2, 5	3 4	0.15		300 300	-	A, D	
		Dual	RC324	RA	25	2, 3	-	2, 5	-	2, 5		0.15	4.0 1.0-	300	-	-	
		Dual	RC342	RA	25	2, 2	-	2, 5	-	2, 5	4	0.15	4.0	300	-	_	
		Dual	RC344	RA	25	2, 3	_	2, 5	_	2, 5	4	0.15	4.0	300	_	_	
		_	RC1031	RA	25	3	_	5	_	15	3	0.225	4.0	300	0 to 65	-	
		_	RC1032	RA	25	3	_	4	_	15	3	0.25	3.0	200	0 to 65	_	
		_	RC1231	RA	25	3	_	5	_	15	3	0.225	3.0	300	0 to 65		
		-	RC1232	RA	25	3	_	4		15	3	0.223	3.0	200	0 to 65		
		_ Dual Inverter Dual	WS277 A10 A11	WH CBS CBS	25		3 1 5		6 5 30	15 †180	3	0.23 0.5 0.30 0.30	2.0 1.0 0.65	275		- G G	† μw † μw

May 17, 1966 181

See pages 4-9 for manufacturer's name.
 -55° to +125°C unless otherwise indicated.
 MC= Multiple Chip; TF= Thin-film hybrid.

DCTL and RTL (continued)

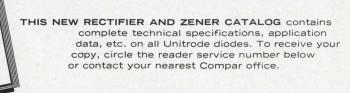
					Propaga- tion Delay		n-in	Fan	_	Diss.	Supply Voltage	Lev (Vol	els ts)	Noise Margin	Temp Range	Package	3
	Logic Function	Туре	Model	Mfr.1	(ns)	Тур.	Max.	Typ.	Max.	(mW)	(Volts)	"0"	"1"	(mV)	(°C)	Туре	Remarks
E	2	3-input	A14	CBS	3000	-	1	-	5	†120	7 max	0.30	0.65	-	-	G	†μw
Gate Expanders F		Dual 3-input Dual 3-input Dual 2-input Dual 2-input Dual 2 -input - Dual 2-input Dual 2-input Dual 2-input	E11001 E11004 MC721G MC921G SN1732 PL921 FµL92129 MWµL921		12 12 25 25 35 40 —	- - - - 2 -	- 2 2 2 - 2.66 2.66	111111	- - - - 3 0.5 0.5	1 - 1 - 0 0 -	3 3.6 3 - 3 3.6 3	0.12 0.12 0.9 0.9 0 0 0.25 0.220		250 250 250 150 - 300 5 350	70 15 to 55 - - 15 to 55	A A A A, D A, C A, C	
Inverters G		Quad Quad Quad	MC727G MC827G MC927G	MO MO MO					- 5 5	- 48 48	3.6 3 3	1.1 1.1 1.1	0.1 0.1 0.1	- 1 -	15 to 55 0 to 100	A A A	
Multivibrators H		Single-shot Single-shot	T35-002 A15	AL CBS	100 4000	-	- 5	-	_ 25	20 †408	3 7 max	0.12 0.30	1.1 0.65	-	-	A G	†μw
Shift Registers I		Full 2-Phase Full 2-phase JK Full JK Full Full Full Half Half Half Half Half Half Half Ha	P11001 P11004 R11001 R110004 RC301 PL913 NB1005 PL905 FµL905 MC705G MC705G MC706G S11001 µL906 MC806G MC906G PL906 MC806G SN1735	AL AL RA PH NA PH FA MO MO AL AL FA MO MO PH MO TI	35 35 35 60 80 80 11 11 15 18 20 20 22 22 22 22 22 22 22 22 22 22 22					84 84 84 84 15 53 53 53 53 50 36 64 43 36 43 15	3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	0.12 0.12 0.12 0.12 0.12 0.18 0 0.25 0.15 1.1 0.12 0.12 0.15 1.1 1.1 1.1	1.1 1.1 1.1 1.1 -0.8 0.86 1.0 0.1 0.1 1.1 1.1 1.0 0.1 0.1 0.1		70 -70 -70 -15 to 55 -15 to 55 -70 -0 to 100 	A A A A A A A A A A A A A A A A A A A	

- 1) See pages 4-9 for manufacturer's name. 2) -55° to $+125^{\circ}$ C unless otherwise indicated. 3) MC= Multiple Chip; TF= Thin-film hybrid.

Who makes what in DCTL/RTL

						Gate	s				
Manufacturer	Symbol	Adders	Binary Elements	Buffers	Counter Adapters	NAND/ NOR	NOR	Gate Expanders	Inverters	Multivibrators	Shift Registers
Amelco	AL	•	•	•	•	•		•		•	•
CBS	CBS		•				•			•	
Fairchild	FA	•	•	•		•	•	•			•
Intellux	IN		•			•					
Motorola	MO	•	•	•	•	•		•	•		•
National Semiconductor	NA	•	•	•	•		•				•
Philco	РН	•	•	•	•	•	•	•			•
Raytheon	RA						•				•
Siliconix	SI	•									
Texas Instruments	TI	•		•		•					•
Westinghouse	WH						•				

FIRST in power rectifiers: 4 amps this size 2 amps this size FIRST in power zeners: 5 watts this size 3 watts this size FIRST in high voltage assemblies: 7500 volts @ 2 amps FIRST in fast recovery 2 amps this size rectifiers: recovers in 75 Nsec FIRST in radiation 2 amps this size resistant diodes: @ 2 x 1014 NVT High surge capability: 100 amp or 250 watt this size Stability: All parts meet initial specifications for each parameter ALL HAVE: after 2000 hours life test at 100°C at full rating Controlled avalanche: Equal surge capability in both forward and reverse directions Reliability: Failure rate < 0.0052%/1000 hours at 60% confidence without acceleration factors









580 PLEASANT STREET • WATERTOWN, MASSACHUSETTS 02172 • TELEPHONE (617) 926-0404 • TWX (710) 327-1296

3. Transistor-Transistor Logic

					Propaga-	F.	n-in	F	-out		Supply	Lev (Vo	els	Noise	Temp		
	Logic Function	Туре	Model	Mfr.	Delay (ns)	Тур.		Typ.	Max.	Diss. (mW)	Voltage (Volts)	"0"	"]"	Margin (mV)	Range (°C)	Package Type	Remarks
Adders A		Half Full	SG90,SG91 SG92,SG93 SN5480		12 Add: 70 Carry: 8	-	-	6	20 –	15 105	4.5 - 5.5	-	-	1000	-	- D	Differ in Temp & F.O. Includes gating
		Full	SN7480	TI	Add: 70 Carry: 8	-	-	-	-	105	4.75 5.25	-	-	1000	0 to 70	D	Includes gating
Binary Elements		R-S Clocked	SF10,SF11 SF12,SF13 SF20,SF21	}	12		-	6	20 20	15 15	-	-		1000	-	-	Differ in Temp & F.O. Differ in
		Single-phase	SF22, SF23 SF30, SF31	,SY	12	-	-	6	20	15	-	_	-	1000	- /4	-	Temp & F.O. Differ in
		J-K J-K Dual Dual Dual Dual J-K J-K J-K Dual latch Dual latch	SF32,SF33 SF50,51 SF52,53 TFF 3011 TFF3013 TFF3015 TFF3017 SE826 SF60,61 SF62,63 SE825 SN5474 SN7474	SY	12 12 18 18 18 18 20 25 25 25 30 30 30		4 4 3 3 2 2 - 4 4		15 12 20 7 20 7 5 15 12 10 10	15 15 30 30 30 30 50 45 45 45 40/ff	4.75-	0.26 0.26 0.20 0.20 0.20 0.20 0.4 .26 .26 0.4	3.3 3.0 3.0 3.0 3.0 2.4 3.3 3.3 2.4	1000 1000 1000 1000 1000 1000 1000 100	0,+75 - - - - 0,+75 - 0 to 70	D, G D, F A, F A, F D, G F D D	Temp & F.O.
		Dual M/S Master/Slave	SN5473 SN7472	TI	35 35		=	Ξ	10 10	50 / 50	5.25 4.5 - 5.5 4.75- 5.25	_	-	1000 100	- 0 to 70	D D	
		Dual M/S	SN7473	TI	35	-	-	-	10	4	f 4.75- 5.25	-	-	1000	0 to 70	D	
		J-K J-K	SW5470 SW7470 SN5470	SW SW TI	40 40 40	6 6 -	-	10 10 -	- 10	65 65 60	4.5-5.5 4.8-5.3 4.5 to 5.5	0.4 0.45 -	3 -	1000 900 1000	0 to +75	_ _ D	Single-phase
		Master/Slave J-K	SN5472 SN7470	TI	35 40	-	-	-	10 10	50 60	4.5 - 5.5 4.75- 5.25	_	-	1000 1000	_ 0-70	D D	Single phase
		J-K/R-S J-K/R-S	SN54948 SN74948	TI TI	40 40	-	-	-	10 10	60 60	4.5-5.5 4.75-	-	-	1000 1000	_ 0-70	D D	
		Gated RS FF R-S R-S R-S Dual Dual Dual J-K	MC652 SWF10 SWF11 SWF13 SWF20 SWF21 SWF22 SWF23 SWF51 SWF52 SWF55 SWF250 SWF251 SWF252 SWF250 SWF251 SWF252 SWF250 SWF251 SWF252 SWF252 SWF252 SWF252 SWF252 SWF252 SWF252 SWF252 SWF252 SWF252 SWF252 SWF252 SWF252 SWF252 SWF252 SWF252 SWF252 SWF252 SWF253 SWF252 SWF253 SWF252 SWF253 SWF252 SWF253 SWF252 SWF253	SY	80 20MHz 30MHz	666666666666666666666666666666666666666	6	- 15 7 12 6 15 7 12 6 10 5 10 5 	4	200 30 30 30 35 35 35 50 50 55 55 55 55 55 55 55 55 55	5.25 10 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 6 4.5-6 6 4.5-6 6 4.5-6 6 4.5-6 6 4.5-6 6 4.5-6 6 4.5-6 6 4.5-6 6 4.5-6 6 4.5-6 4.5-6 6 6 6 6 6 6 6 7 6 7 8 7 8 8 8 8 8 8 8	10 0.4 0.45 0.45 0.45 0.4 0.4 0.45 0.45 0	.70 33 33 33 33 33 33 33 33 33 33 33 33 33	5V 1000 1000 900 900 1000 900 1000 900 1000 1000 1000 900 9	0 to 75 0 to +75 0, +75	A, C	
Orivers / Buffers	in the second	Dual Triple 2-input Triple 2-input Dual 4-input	SE855 SG160,161 SG162,163 SN54932	SIG SY	15 15 15 18		4		30 15 12 30	25 15 15 25/ gate	+5 - - 4.5-5.5	0.4 0.26 0.26 -	2.4 3.3 3.3 -	1000 1000 1000 1000	- 0 to 75	F D, G D, G	

See pages 4-9 for manufacturer's name.
 -55° to +125°C unless otherwise indicated.
 MC= Multiple Chip; TF= Thin-film hybrid.

TTL (continued)

	Logic Function	Туре	Model	Mfr.	Propaga- tion Delay (ns)	Fa Typ.	n-in Max.	Fan	-out	Diss.	Supply Voltage (Volts)	Log Lev (Vol	els ts)	Noise Margin (mV)	Temp Range (°C)	Package Type	3 Remarks
С		Dual 4-input	SN74932	TI	18	-	-	-	30	25/	4.75-	-	-	1000	0 to 70	D	
		Dual 4-input Dual 4-input	SG130, 13 SG132,13		25 25	-	<u>-</u>	-	30 24	gate 30 30	5.25	0.26 0.26	3.3		- 0 to 75	D, G D, G	
D	AND/OR/NOT	Dual 4-input Dual 4-input Dual 4-input Dual 4-input Expandable Quad Expandable Quad Expandable Quad Expandable Quad Dual Dual 4-input Dual 4-input Dual 4-input Dual 4-input Quad 2-input Quad 2-input Quad 2-input Quad 2-input Dual Triple 3-input	SWG210 SWG211 SWG212 SWG213 SWG250 SWG251 SWG253 SWG5A SWG5B SWG110 SWG111 SWG112 SWG113 SWG50 SWG51 SWG53 SWG53 SWG53 SWG53 SWG53 SWG51 SWG103 SWG103 SWG103 SWG103 SWG103	SW SW SW SW SW SW SW SW SW SW SW SW SW S	7 7 7 7 7.5 7.5 7.5 12 12 13 13 13 14 14 14 14 15 15 15 15	4 4 4 4 9 9 9 9 9 9 - - 20 20 20 20 20 20 20 20 20 20 20 20 20	3 4	12 6 10 5 6 6 10 5 7 12 6 15 7 12 6 7 7 12 6	15 15 10	30 30 30 30 43 43 43 43 15 15 20 20 20 20 20 20 20 20 25 25 25 25	4.5-6 4.5-6-6 4.5-5-6 4.5-5-6 4.5-6	0.4 0.45 0.45 0.45 0.45 0.45 0.5 0.4 0.4 0.45 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4	3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	1000 1000 900 900 1000 1000 1000 1000 1	- 0 to +75 - 0 to +75 - 0 to +75 0 to +	A A	Expandable
	NAND 2	Quad 2-input Quad 2-input Quad 2-input Quad 2-input Quad 2-input Dual 4-input Dual 4-input B-input B-i	SWG220 SWG221 SWG222 SWG223 SWG240 SWG242 SWG263 SWG261 SWG263 SE808 SE816 SE808 SE816 SE800 SW104 SWG44 SWG44 SWG44 SWG41 SWG	SW S	6 6 6 6 6 6 6 6 8 8 8 8 8 8 8 10 10 10 10 10 10 11 11 11 11 12 12 12 12 12 12 12 12 12	22224446688888	4	12 6 10 5 12 6 10 - 12 6 10 5 - - - - - - - 15 7 12 6 15 15 15 15 15 15 15 16 16 16 16 16 17 17 17 17 18 18 18 18 18 18 18 18 18 18 18 18 18		22 22 22 22 22 22 22 22 22 22 22 22 22	4.5-6-6-6-6-6-6-6-6-6-6-6-6-6-6-6-6-6-6-6	0.4 0.4 0.45 0.45	33333333333333333333333333333333333333	1000 1000 900 900 1000 900 900 1000 100	- 0 to +75 - 0 to +75 0 to +75		

May 17, 1966 185

¹⁾ See pages 4-9 for manufacturer's name.
2) -55° to +125°C unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

TTL (continued)

					Propaga-	Fa	n-in	Fon	-out		Supply	Leve (Vol	els	Noise	Temp		
	Logic Function	Туре	Model	Mfr.	Delay (ns)	Typ.	Max.	Тур.		Diss.	Voltage (Volts)	"0"	"]"	Margin (mV)	Range (°C)	Package Type	Remarks
D	2	Triple 3-input	SN5410	TI	13	-	-	-	10	10/	4.5to	-	-	1000	-	D	
		Dual 4-input	SN5420	TI	13	-	-	-	10	gate 10/	5.5 4.5 to	-	-	1000	-	D	
		Quad 2 - input	SN7400	TI	13	-	-	-	10	gate 10/	5.5 4.75 -	-	-	1000	0-70	D	
		Triple 3 - input	SN7410	TI	13	-	-	-	10	gate 10/	5.25 4.75 -	-	-	1000	0-70	D	
		Dual 4-input	SN7420	TI	13	-	-	-	10	gate 10/	5.25 4.75 –	-	-	1000	0-70	D	
		Dual 4-input	SN54930	TI	13	-	-	-	10	gate 10/	5.25 4.5-5.5	-	-	1000	-	D	
		Quad 2-input	SN54946	TI	13	-	-	-	10	gate 10/	4.5-5.5	-	-	1000	-	D	
		Triple 3-input	SN54962	TI	13	-	-	-	10	gate 10/	4.5-5.5	-	-	1000	-	D	
		Dual 4-input	SN74930	TI	13	-	-	-	10	gate 10/	4.75-	-	-	1000	0 to 70	D	
		Triple 3-input	SN74962	ТІ	13	_	_	-	10	gate 10/	5.25 4.75-	_	_	1000	0 to 70	D	1
		Quad 2-input	SN74946	TI	13	_	_	_	10	gate 10/	5.25 4.75-	_	-	1000	0 to 70	D	
		8-input	SW5430	SW	15	8	-	10	-	gate 10	5.25 4.5-5.5	0.4	3	1000	_	-	
		8-input 8-input	SW7430 SWG60	SW	15 15	8	-	10 7	-	10 15	4.8-5.3 4.5-6	0.45	3	900	0 to 75	-	
		8-input 8-input	SWG61 SWG62	SW	15 15	8	-	7 12	-	15 15	4.5-6 4.5-6	0.4	3 3 3	1000	0 to +75	_	
		8-input	SWG63	SW	15	8	-	6	-	15	4.5-6	0.45	3	900	0 to +75	_ D	
		8-input	SN5430	TI	15	-	-	-	10	10	4.5 to. 5.5	-	-	1000	0-70	D	
		8 - input	SN7430	TI	15	-	-	-	10	10	4.75 - 5.25	-	-	1000	0-70		
		8-input 8-input	SN54965 SN74965	TI	15 15	-	-	-	10	10	4.5-5.5 4.75-	_	-	1000 1000	0 to 70	D D	
		-	SWG16	SW	15	-	8	7	-	15	5.25	0.5	3.0	1000	-	A	
		8-input 8-input	SWG120 SWG121	SW	16 16	20 20	-	7 7	_	15 15	4.5-6 4.5-6	0.4	3	1000	-	_	Expandable Expandable
		8-input 8-input	SWG122 SWG123	SW	16 16	20 20	-	12	-	15 15	4.5-6 4.5-6	0.45	3	900	0 to +75 0 to +75	_	Expandable Expandable
		Dual 4-input Dual 4-input	SW5440 SW7440	SW	17.5 17.5	4	-	30	-	10	4.5-5.5 4.8-5.3	0.4	3	1000	0 to +75	-	
		Dual 4-input	SN5440	TI	18 ~	-	-	-	30	25/ gate	4.5 to 5.5	-	-	1000	-	D	Power gate
		Dual 4-input	SN7440	TI	18	-	-	-	30	25/ gate	4.75- 5.25	-	-	1000	0-70	D	Power gate
		Dual	SW402	SW	100	-	3	-	5	0.10	3.0	0.3	2.0	300	-	Α	
	NAND/NOR 3	Quad 2-input Quad 2-input	SG220,221 SG222,223 SG240,241	SY	6	-	-	-	12 10	22 22	_	0.25	3.5	1000 1000	0 to 75	D, G D, G	
	3	Dual 4-input Dual 4-input	SG242,243	SY	6	-	-	-	12 10	22 22 22	-	0.25	3.5	1000 1000	0,+75	D, G D, G D, G	
		Single 8-input Single 8-input	SG260,261 SG262,263	SY	8	-	-	-	12	22 22	-	0.25	3.5	1000	0 to 75	D, G D, G	
		-	B01	SI	10	-	8	-	15	16.5	4.5	0.5	2.3	1000	-55 to 165	A, D	
		Dual -	B02 TNG3041	SI	10 10	-	8	-	15 20	16.5	4.5 5-6	0.5	2.3	1000 1000	-55 to 165	A, F	
		200	TNG3043 TNG3045	TR	10 10	_	8	_	7 20	15 15	5-6 5-6	0.20	3.0	1000	_	A, F	2 - 11
		_ Dual	TNG3047 TNG3141	TR TR	10 10	-	6	-	7 20	15 15	5-6 5-6	0.20	3.0	1000 1000	_	A, F A, F	
		Dual	TNG3143	TR	10	-	4	-	7	15	5-6	0.20	3.0	1000	-	A, F	
		Dual Dual	TNG3145 TNG3147	TR	10 10	_	3	-	20	15 15	5-6 5-6	0.20	3.0	1000 1000	-	A, F A, F	
		Dual Dual	TNG3241 TNG3243	TR	10 10	_	4	_	20	15 15	5-6 5-6	0.20	3.0	1000	-	A, F A, F	
		Dual Dual	TNG3245	TR	10	-	3	-	20	15	5-6 5-6	0.20	3.0	1000 1000	_	A, F A, F	
		Triple 3-input Triple 3-input	TNG3247 SG190,191 SG192,193	SY	10 10	=	-	-	15 12	15 15 15	-	0.20 0.26 0.26	3.3	1000	-	D, G	
		Dual 4-input	1 3640,364.	1.21	12	-	-	6	20	15	_	-	-	1000	0,+75	D, G -	Differ in
		Single 8-input	SG42, SG43 SG60, SG63	I,SY	12	-	-	6	20	15	_	-	-	1000	_	_	Temp & F.O. Differ in

See pages 4-9 for manufacturer's name.
 -55° to +125°C unless otherwise indicated.
 MC= Multiple Chip; TF= Thin-film hybrid.

TTL (continued)

	Logic Function	Туре	Model	Mfr.	Propaga- tion Delay (ns)		n-in Max.	Fan	-out	Diss.	Supply Voltage (Volts)	Lev (Vol	els	Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks 3
D	3	Expandable	TTμL103	TR T	12 15 15 15 15 15 15 15 15 15 15 15 15 15		88666444333244848484848	6 	20 7 20 7 7 7 20 7 7 20 7 7 20 7 7 20 7 7 7 20 7 7 20 7	15 15 15 15 15 15 15 15 15 15 15 15 15 1	- 6666666666666666600 - 55555555555555555555555555555555555	0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20	3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0	1000 1000 1000 1000 1000 1000 1000 100		- A,	Differ in Temp & F.O.
	Exclusive OR	Dual 4-input Dual 4-input Quad 2-input Quad 2-input Quad 2-input Dual Single 8-input Maj. Voter - Dual Dual Dual Dual Dual Dual Dual Dua	\$G210,211 \$G212,213 \$G250,251 \$G252,253 \$E840 \$G50,\$G51 \$G52,\$G53 \$G100,101 \$G102,103 \$G110,111 \$G112,113 \$WG90 \$WG91 \$WG91 \$WG92 \$WG93 \$W5450 \$W7450 \$N5450 \$N5451 \$N7451 \$N7451 \$N7456 \$N74966	SY SY SIG SY SY	7 7 7 7.5 7.5 10 12 12 12 12 14 14 14 14 15 15 15 15 15	- - - - - - 6 6 6 6 6 6 20 20 -		- - - - 6 6 6 6 15 7 12 6 6 10 10 - -	12 10 12 10 10 20 20 20 20 	30 30 43 43 43 14 15 15 15 15 30 30 30 10 10 14/ gate 14/ gate 14/ gate 14/ gate 14/ gate		0.25 0.25 0.25 0.25 0.4 - - - 0.4 0.45 0.45 - - - -	3.5	1000 1000 1000 1000 1000 1000 1000 100	0 to 75 0, +75 - 0 to +75 - 0 to +75 0 to +75 0 to +75 - 0 to 70 0 to 70	D, G D, G D, G D, G F - - - D D	Expandable Expandable Differ in Temp & F.O. Differ in Temp & F.O. Differ in Temp & F.O. Expandable Expandable Expander Inputs
Gate Expanders E		Quad 2-input Quad 2-input Quad 2-input Quad 2-input Quad 2-input Dual 4-input Dual 4-input Dual 4-input Quad 2-input Quad 2-input Quad 2-input Quad 4-input Dual 4-input Dual 4-input Quad Quad Quad Quad Quad Quad	SWG230 SWG231 SWG231 SWG233 SWG270 SWG271 SWG272 SWG273 SG230,231 SG230,231 SG270,271 SG272,273 SE806 SWG150 SWG151 SWG152 SWG153 SWG153 SWG170	SY	2 2 2 2 2 2 2 2 2 2 2 2 2	8 8 8 8 8 8 8 8 	- - - - - - - - - - - - - - - - - - -		- - - - 12 10 15 12 4 - -	28 28 28 28 6.7 6.7 6.7 6.7 28 6.7 6.7 5 5 5	4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6	- - - 0.25 0.25 0.25 0.25 0.4 - -	- - - - 3.5 3.5 3.5 3.5 2.0 - - -		0 to +75 0 to +75 0 to +75 0 to +75 0 to +75 0 to 75 0 to 75		

May 17, 1966 187

¹⁾ See pages 4-9 for manufacturer's name. 2) -55° to $+125^{\circ}$ C unless otherwise indicated. 3) MC= Multiple Chip; TF= Thin-film hybrid.

TTL (continued)

					Propaga- tion Delay		n-in		-out	Diss.	Supply Voltage	Lev (Vol	els lts)	Noise Margin	Temp Range	Package	3
	Logic Function	Туре	Model	Mfr.1	(ns)	Typ.	Max.	Typ.	Max.	(mW)	(Volts)	"0"	"]"	(mV)	(°C)	Туре	Remarks
Е		Dual 4-input	SWG171 SWG172 SWG173 SWG180 SWG181 SWG182	SW SW SW SW SW	1.11.1.1	8 8 8 8 8		11111	11111	5 5 5 1 1	4.5-6 4.5-6 4.5-6 4.5-6 4.5-6 4.5-6	11111	111111	111111	- 0 to +75 0 to +75 0 to +75		
		Dual 4-input Dual 4-input Dual 4-input 3-input	SWG183 SW5460 SW7460 SG170,17 SG172,17			8 4 4 -		1111	1111	1 5 5 15	4.5-6 4.5-5.5 4.8-5.3		1111	1000	0 to +75 - 0 to +75	-	Differ in Temp & F.O.
		Dual 3-input Dual 4-input	SG180, 18 SG182, 18 SN5460	1 SY	-	-	-	6	20	15 5/exp.		1 1		1000	-	_ D	Differ in Temp & F.O.
		Dual 4-input	SN7460	TI	-	-	-	-	4	5/exp	5.5 4.75- 5.25	-	-	1000	0 to 70	D	
		-	TNG3051 TNG3251		-	=	8 4	-	-	5 5	5-6 5-6	0.20			Ξ	A, F A, F	
verters F		Quad 2 - input	SN5453	TI	15	-	-	-	10	25	4.5 - 5.	5 -	-	1000	-	D	

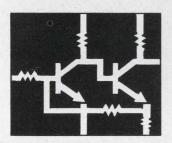
- See pages 4-9 for manufacturer's name.
 -55° to +125°C unless otherwise indicated.
 MC= Multiple Chip; TF= Thin-film hybrid.

Who makes what in TTL

						G	ates			
Manufacturer	Symbol	Adders	Binary Elements	Drivers/ Buffers	AND/OR/ NOT	NAND	NAND/ NOR	Exclusive- OR	Gate Expanders	Inverters
Fairchild	FA						•			
Motorola	MO		•							
Philco	PH						•			
Signetics	SIG		•	•		•		•	•	
Siliconix	SI						•			
Stewart-Warner	SW		•		•	•		•	•	
Sylvania	SY	•	•	•			•	•	•	
Texas Instruments	TI	•	•	•	•	•		•	•	•
Transitron	TR		•				•		•	
Westinghouse	WH									

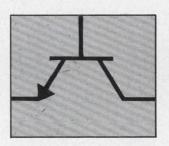
Amelco high-reliability silicon epitaxial devices





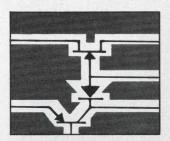
MONOLITHIC LINEAR INTEGRATED CIRCUITS

These high-performance differential amplifiers, operational amplifiers and video amplifiers are the result of advanced planar diffusion techniques. Precise photo-etching and diffusion processes result in closely matched diffused resistors and small geometry transistors for high performance.



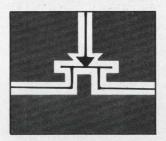
TRANSISTORS

Covering General Purpose, Small Signal Amplifiers and High Frequency types Amelco Transistors are of the passivated planar silicon diffused construction. Small Signal transistors provide excellent gain at low collector currents, and High Frequency devices benefit from precise control of small geometries.



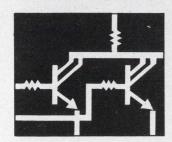
HYBRID LINEAR INTEGRATED CIRCUITS

Characterized by high reliability and low cost engineering, these circuits utilize thin-film deposition on ceramic substrates for passive components and interconnections, and die attached active components. Standard circuits include analog gates amplifiers, multivibrators and counters, with a variety of custom circuits readily available.



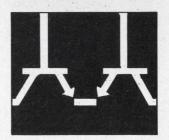
FIELD EFFECT TRANSISTORS

Amelco offers an extensive line of N channel silicon FET's, noted for high transconductance, low noise, low leakage and high reliability. These devices are made by passivated planar diffusion techniques and are specified in a wide range of Pinch-Off Voltage and other parameters. Available in metal cans or epoxy packages.



MONOLITHIC INTEGRATED LOGIC CIRCUITS

Amelco digital circuits encompass Direct Coupled Transistor Logic (DCTL) and Transistor-Transistor Logic (T²L). DCTL, called OMIC for Optimized Micro-circuits, include transistors with dual collectors for improved performance. Available in 3 grades and over 14 circuits. T²L circuits are designed for high packaging density and low power dissipation to meet the requirements of airborne systems.



DIFFERENTIAL AMPLIFIERS

Amelco 'Diff Amps' consist of two silicon transistors in a single package. The transistors are matched to close tolerances for use in many critical applications. Both conventional and field effect transistors are used.

Amelco's superior reliability and performance are in large part due to proprietary methods of ultra-precision photomasking and mask alignment combined with total quality control over the entire production process. Prompt attention is given to all inquiries through the home office or through Amelco Field Sales Offices, Representatives, and Distributors throughout the free World.

AMELCO SEMICONDUCTOR

DIVISION OF TELEDYNE, INC. 1300 TERRA BELLA AVENUE • MOUNTAIN VIEW, CALIFORNIA Mail Address: P. O. Box 1030, Mountain View, California Phone: (415) 968-9241 / TWX: (415) 969-9112 / Telex: 34-8416

ON READER-SERVICE CARD CIRCLE 59

4. Emitter-Coupled Logic

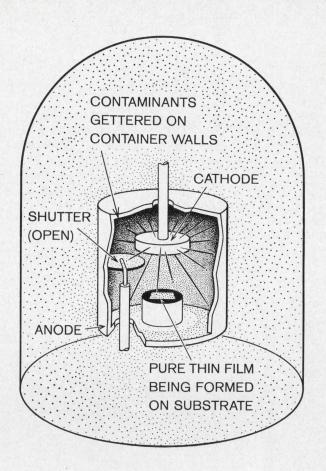
	Logic Function	Туре	Model	Mfr.	Propaga- tion Delay (ns)		n-in Max.	Fan Typ.	-out Max.	Diss.	Supply Voltage (Volts)	Leve (Vol	els ts)	Noise Margin (mV)	Temp Range (°C)	Package Type	3 Remarks
Adders		Half Half	MC303 MC353	MO MO	6	- -	-		25 25	60 60	10 10	1.55 1.55	0.75 0.75	-	_ 0 to 75	A, C A, C	
Binary Elements B		Set-Reset J-K Set-Reset J-K JK	MC302 MC308 MC352 MC358 SW308	MO MO MO SW	10 10 10 10 10				25 - 25 - 25	35 52 35 52 52	10 10 10 10 -5.2	1.55 1.55 1.55 1.55 -1.55	0.75 0.75 0.75 0.75 -0.75	_	- 0 to 75 0 to 75 -	A, C A, C A, C A, C A, C	
Drivers C		Line & Capacity Line & Capacity - -	MC315 MC365 MC304 MC354 SW304	WO WO MO	10 10 - - -	3 3 - -	25 25 - -	- - 5 5 5	25 25 25 25 25 25	- - 18 18 18	-5.2 -5.2 10 10 -5.2	1.55 1.55 - -	0.75 0.75 - -		- 0 to 75 - 0 to 75 -	A, C A, C A, C A, C A, C	
Gates D	NOR 1	Dual 2-input Dual 2-input	MC309 MC310 MC311 MC359	МО	6	-	-	-	26	49	10	1.55	0.75		- 0 to 75	A, C	Units differ in output configuration Units differ in output
		Dual	MC360 MC361 SW309 SW310 SW311	SW	6	-	2	-	26	49	-5.2	-1.5	-0.75	-	-	A, C	configuration Units differ in output con- figuration
		Dual Dual Dual	MC312 MC362 WS371	MO MO WH	6.5 6.5 10	- - 4	3 3 4	- - 25	25 25 -	68 68 220	5.2 5.2 -5.0	75 75 -1.6	-1.6 -1.6 -0.8		0 to 75 0 to 75	A, C A, C C	
	OR/NOR	Dual	SN7000	TI	5	-	-	-	-	40/ gate	+1.25-	-	-	250	0 to 70	D	4 load resistors
	2	Dual	SN7001	TI	5	-	-	-	-	40/ gate	+1.25-	-	-	250	0 to 70	D	2 load resistors
		_	SW301 SW306 SW307	SW	6	3	5 25	-	26 26	35 35	-5.2 -5.2	-1.55 -1.55			Ξ	A, C A, C	Units differ in output configuration
	OR/NOR/AND	5-input	MC301	МО	6	3	25	-	26	35	10	1.55	0.75	-	-	A, C	
	NAND 3	3-input	MC306 MC307	MO	6	3	25	-	26	35	10	1.55	0.75	-	- /	A, C	
		5-input 3-input	MC357 MC356 MC357	MO MO	6	3 3	5 25	-	26 26	35 35	10 10	1.55 1.55	0.75 0.75		0 to 75 0 to 75	A, C A, C	
Gate Expanders E		- - -	MC305 MC355 SW305	MO MO SW	6 6 6	-				-	10 10 -5.2		=	-2-	- 0 to 75 -	A, C A, C A, C	
Level Translator	s	DTL to CML CML to DTL	MC1511 MC1512	MO MO	-	-	1 25	-	25 -	25 80	-	-1.97 -0.75	-0.75 2.95		Ξ	A A	

190

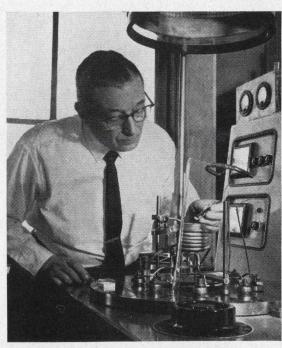
See pages 4-9 for manufacturer's name.
 -55° to +125°C unless otherwise indicated.
 MC= Multiple Chip; TF= Thin-film hybrid.

Report from
BELL
LABORATORIES

Diagram illustrating formation of high-purity thin film at ordinary vacuum level: Cathode consists of reactive metal which, transferred to substrate, forms thin film. Anode is shaped into enclosing cylinder. Surrounding atmosphere consists of argon and unwanted contaminants. When 1500-volt potential is applied, ionized argon "sputters" metal from cathode. During sputtering, metal atoms "getter" the contaminants—i.e., remove them from surroundings and hold them at the container walls. Then a protective shutter is swung aside (as shown here) and pure, uncontaminated metal travels from the cathode to the substrate to form the film.



High-purity thin films



H. C. Theuerer of Bell Laboratories prepares to place a thin-film substrate in getter sputtering equipment.

Very thin films of metal offer many opportunities for achieving small high-performance, high-reliability electronic circuits. And the technology has now reached the point where numerous problems related to thin films are being solved.

One of these problems was contamination of the films during preparation. At ordinary levels of vacuum, enough contaminants remained in the surrounding atmosphere to harm the characteristics of the film. Yet establishing an ultrahigh vacuum is expensive and time-consuming.

A solution was found by H. C. Theuerer at Bell Telephone Laboratories. It consists of letting reactive metals do double duty. As shown in the drawing, the same metal that forms the film also removes the contaminants from the atmosphere. With the new process, known as "getter sputtering," film purities that formerly required a 10⁻¹² Torr vacuum can now be achieved with 10⁻⁶ Torr equipment.



May 17, 1966

5. Resistor-Capacitor Transistor Logic

								_	-			_					
	Logic Function	Туре	Model	Mfr!	Propaga- tion Delay (ns)	-	n-in Max.	Fan	-out	Diss.	Supply Voltage (Volts)	Lev (Vo	els	Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
Binary Elements A		J-K R-S-T Schmitt Trigg R-S FF/Counter R-S R-S R-S Ripple-Counter Ripple-Counter	FF7317E FF8317E TMC40003 ST2514B SN510B SN511B SN5111 SN5111 SN5111 SN5112 SN5113 USO100A USO101A	IN	8 8 10 20 300 300 300 300 300 300 300 300	2 3 - 1	2 3 1	5	4 4 5 6 4 20 16 16 4 20	96 96 48 145 2@3V 2@3V 3@3V 3@3V 4@4V 2-7 2-7	6 6 +6, -3 12 3-6 3-6 3-6 3-6 3-6 3-6 3-6 3-6 3-6	0.2 0.2 0 0.2 - - - 2.5 2.5	<6 <6 6 <12 0.3 0.3	1500 1500 1000 2500 200 200 200 200 200 200 200		666600000000000000000000000000000000000	TF TF TFH TF With Emitter Follower Dual Presets Dual Preset
Clock Driver B		-	SN517B	TI		-//	- /	12	20	3@3V	3-6	-	-	200	- 1	D	
Gates C	NAND/NOR	Dual 3-input Inverter 6-input 6-input Dual 3-input	GG3317 TMC40001 TMC40004 SN512B SN513B	MEP TI TI	4 10 10 65@6V 65@6V	3	3 4	5 5	5 5 5 5 25	96 48 48 2@3V 3@3V 2@3V	6 +6, -3 +6, -3 3-6 3-6	0.2	<6 6 6 - -	1500 1000 500 200 200 200	-	G G G D D	TF With Emitter Follower
		Dual 2 - input Triple 2 - input Triple 2 - input	SN516B SN5161B SN5162B	TI TI	65@6 V 65@6 V 65@6 V	-	-	-	25 5 25	2@3V 2/ gate 2/	3-6 3-6 3-6		-	200 200 200	-	D D	Emitter
		Exclusive OR Pulse Exclusive OR	USO102A USO103A SN515B SN5191		100 100 100@6V	1 1 1 1	6 6	1111	5 25 5 5	gate 2-7 2-7 3-93V 6@3V	3-6 3-6 3-6 3-6	2.5 2.5 -	0.3 0.3 -	200 - 200 200		- D D	Follower
Multivibrators D		One-Shot Medium Delay One-shot	TMC40002 DM3510B SN518B	MEP IN TI	10	- 1 -	- 1 -	5 _	5 5 5	48 96 2@3V	+6, -3 12 3-6	0 0.2	6 <12 -	500 2500 200	- 1-1	G G D	TF

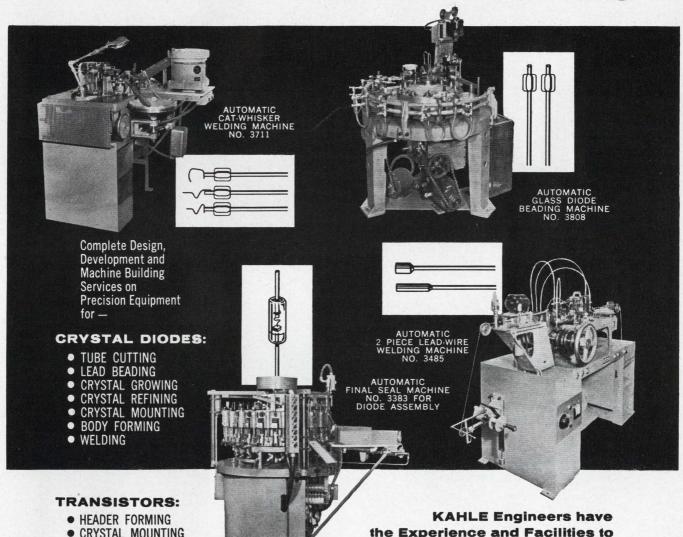
192

¹⁾ See pages 4-9 for manufacturer's name. 2) -55° to $+125^{\circ}$ C unless otherwise indicated. 3) MC= Multiple Chip; TF= Thin-film hybrid.

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6. Complementary Transistor Logic

					Propaga- tion Delay	Far	ı-in	Fan	-out		Supply Voltage	Lev (Vo	els	Noise Margin	Temp Range	Package	2
	Logic Function	Туре	Model	Mfr.1	(ns)	Тур.	Max.	Typ.	Max.		(Volts)	"0"	"1"	(mV)	(°C)	Туре	Remarks
Binary Element		Dual - rank	CTμL951	FA	15-20	-	-	15	-	150	4.5,-2	0.36	2.25	400	15 to 55	G	
Buffers B		-	CTμL956	FA	12	-	-	-	25	125	4.5,-2	0.36	2.25	400	15 to 55	G	
Gates C	AND 1	2,2,3 input Dual 4-input Single 8-input	CT _μ L953 CT _μ L954 CT _μ L955	FA	3 3 3	8 8 8		12 12 12		- - -	4.5,-2 4.5,-2 4.5,-2	0.36 0.36 0.36	2.25	400 400 400	15 to 55 15 to 55 15 to 55	G G G	
	NOR 2		CTμL952	FA	9	-	-	10	-	55	4.5,-2	0.36	2.25	400	15 to 55	G	

- 1) See pages 4-9 for manufacturer's name.
- 2) -55° to $+125^{\circ}$ C unless otherwise indicated.
- 3) MC= Multiple Chip; TF= Thin-film hybrid.



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ELECTRONIC DESIGN

7. Miscellaneous Digital Circuits

	Logic Function	Туре	Model	Mfr.1	Propaga- tion Delay (ns)		n-in Max.	-	-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Log Lev (Vol	els	Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
Counter A		BCD decade BCD decade	SN5490 SN7490	TI TI	†12 MHz †12 MHz	-	-	-		150 150	4.5 - 5.5 4.75 to 5.25			1000 1000	0-70	D D	† Count freq. † Count freq.
Diode Matrix B		- - - Dual 3-input Dual 3-input	* Nine mat MC1116 MC1117 MC1118 MC217 MC267		†10 es avail, fro - - - -	- om 5 x - - -	5 to 15 	x 15 in - - - - -	RM - 50	450 0,60,70 - - - - -	40 series. 40(max) 40(max) 40(max) -	- - - 4 4	- - - .3 .3		- - - - - 0 to 75	D, G A A A, C A, C	†Reverse Recovery Time
Level Detector		-	WM208T	WH	1 MHz	-	-	-	-	-	6	-	-	-	-	A, C, D	
Level Shifter D		-	WS150Q	WH	-	-	-	-	-	100	10, 6.4 -10, -64		5 2.5 - 9.0	- 4	-	С	
Memory E		16 - bit 16 - bit	SN5481 SN7481	TI TI	Read: 25 Write: 25 Read: 25 Write: 25	-	1 1	-		150 150	4.5 - 5.5 4.75 to 5.25	1 1	1 1	1000	0-70	D, J	
MOS F	Adder Analog Switch	Dual - Full 4-channel	MEM1000 PL4S01	GI GME	500 -	-	=	-	5 -	25 150	-26,-12 -15-30+	-2 10	-10 0	1 V 1000	-55 to +85 -	F G	
	Converter Counter Flip-Flop J-K Flip Flop Multiplexer NAND/NOR NOR-Gate Shift Reg.	BCD to Decimal BCD to Binary D to A BCD Decade RST Dual 6 - Channel 5 - Channel 4 - Channel 4 - Channel 4 - Channel 3 - Channel 3 - Channel 3 - Channel Dual 4 - input Dual 3 - input 9 - bit 9 - bit 20 - bit 21 - bit	PL4602 PL4603 PL4502 PL4601 MEM1005 PL4M01 MEM2002 MEM2003 MEM2004 MEM2005 MEM2006 MEM2006 MEM2006 MEM2006 MEM2006 MEM2006 MEM2006 MEM2006 MEM2006 MEM2006 MEM2006 MEM2006	GI GI GI GME GME GME GME GME	0-1MHz 2500 - - - - - - 1000 500 - - - 0-1MHz 0-500MHz				5 5 5 5	100 50 75 75 80 100 	10 -12, -24 -12, -24 -12, -24 -12, -24 -28 -12, -24 -30 -30 -30 -30 -30 -30 -30 -30 -30 -30	-3 -3 -3 -3 -3 -3 -3 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1	-9 -9 -9 -10 - - - - - - - - - 9 -10 -9 -9 -10 -9 -9 -10 -9 -9 -10 -9 -9 -10 -9 -9 -10 -10 -10 -10 -10 -10 -10 -10 -10 -10			FGGGGGGGAGGA AA	– 24v clock
Pulse Source G			NM4002	NOR	25	-	-	-	-	590	+20	0	+3	-		А, В	Apollo pre- core driver
Schmitt Trigger H		-	NC/PC17	GI	8	-	1	-	5	200	12, 4.2, -3	0	5	-	-	A, E	MC RCT
Shift Register		8-bit 8-bit	SN5491 SN7491	TI TI	†15 MHz †15 MHz			-		190 190	4.5 - 5.5 4.75 to 5.25			1000 1000	_ 0-70	D D	† Shift freq. † Shift freq.
Steering Gate J		- 1	NC/PC9	GI	-	-	-	-	-	-	-	-	-	-	-	A, E	MC RCDT
Utilogic K	AND Gate AND Gate NOR Gate NOR Gate NOR Gate OR Gate OR Gate Expander J-K Binary	Single Dual Single Dual Dual Dual Dual Dual Dual Single	SU305 SU306 SU314 SU315 SU316 SU331 SU332 SU300 SU320	SIG SIG SIG SIG SIG SIG SIG SIG	15 15 20 20 20 20 20 20 20 -		6 3 7 3 2 2 3 -	1111111	10 10 17 17 17 17 17 17	5 18 18 18 36 36 5 90	+4.5 +4.5 +4.5 +4.5 +4.5 +4.5 +4.5 +4.5	- 0.6 0.6 0.6 0.6 0.6 -	- 3.3 3.3 3.3 3.3 3.3 - 3.3	- 1200 1200 1200 1200 1200 - 1200	-20, +85 -20, +85 -20, +85 -20, +85 -20, +85 -20, +85 -20, +85 -20, +85 -20, +85	A, C A, C A, C A, C A, C A, C A, C A, C	

195 May 17, 1966

¹⁾ See pages 4-9 for manufacturer's name. 2) -55° to $+125^{\circ}$ C unless otherwise indicated. 3) MC= Multiple Chip; TF= Thin-film hybrid.

8. Linear Circuits

Function	Model	Mfr.1	Frequency Range	In put (Volts)	Gain (db) or *(Volts)	Output (mW) or *(Volts)	Input Impedance (ohms)	Output Impedance (ohms)	Supply Voltage (Volts)	Noise Figure (db) or *(Volts)	Package Type	Remarks 2
Amplifier Demodulator	MCM602	KE	DC-2 kHz	-	*2.6	-	35 k ±10%	4300 ± 10%	±15VDC ±12 VDC	-	G	
Analog switch B	E16-501 45P912 4JP913 PC402 PC401 NM2017	AL GE GE GI NOR	Ton <500 ns Toff <600 ns 100 MHz 100 MHz 200 kHz 200 kHz 200 kHz	±5 0.0006 0.0006 3 3 5	†40 - - - -		- 10 k/3.9 k 10 k/3.9 k 10 k	-	20 20 +45, +28 +45, +28	1 11111	A A A E E D	thFE
Audio Amp. C	AMC101 8502 WC183G	AMP VAR WH	dc-20 KHz 10 Hz - 100 KHz .5-10 KHz	0-20	80 46 94	.002 10 45	10 k 40 k		5 10 to 20 4.5	6 10 *3	G - D	
Bit Driver D	WS151	WH	Ton = 100 ns Toff = 350 ns	-	-	-	5 k	-	10	-	С	
Broadband Amp.	4JP108 PA7600 SE501 WM1146Q	GE PH SIG WH	6 MHz 0-200 MHz 40 MHz dc-100 MHz		*20 †43 28 16	- 2.5 -	50 - 1.3 k	1 -	15 6 6.0 12	- 5 4 dB 4	A A, C C	†MHz Video Bandwidth
D/A Switch F	4JP380	GE	250 MHz	-	-	-		20	5	-	A	
Demodulator ChopperG	NM2024	NOR	5 kHz	26	-	-	-1.077	-	28	-	D	
Differential Amp. H	D13-000 D13-002 D13-002 D13-002 PC201 PC200 PC201 MC1525 MC1527 MC1526 MC1526 MC1527 MC1528 MC1527 MC1528 MC1528 MC1528 MC1527 MC1528 M	MO MO MO MO MO NOR NOR SIG SSD TI TI TI TI WH WH WH WH	400 kHz 400 kHz 400 kHz 400 kHz 400 kHz 100 kHz 100 kHz 1100 kHz 1400 kHz 1400 kHz 1400 kHz 1400 kHz 1000 kHz	- + 1 mV - 20.040 - ±5 - ±5 - ±5 - ±5 - ±5 - 12mV - 14mV - ±3 - ±3 - ±5 - ±4 	45 45 45 63 73 73 20 73/45 140 65 140 65 75 66 60 *1500 Open L 40 64 40 63 hfe = 50	*16 *8 *6 - coop 150 4 4 4 0.4 18 000 -	100 k Diff. 200 k Diff. 20 k Diff. 2 M 2.6 k/1.2 k† 60 k 2.2 k 80 k 3.2 k 250 k 1.5 M 4 k 75,000 10 k 100 k 100 k 100 k 100 k 20 k 3.5 k 1 M 50 k 20 k 20 k 20 k 20 k	11 k 11 k 11 k 11 k 100 100 5 k - 300 10 k 10 k 35 8 k 0.5 k	±12 ±12 ±12, -6 ±2 to ±22 ±6 to ±22 ±14 ±14 ±14 ±14 ±14, -6 10 +12, /25 +6, -3 25 ±12 ±12 ±12 ±12 ±12 ±12, -6 12, -6 6, -12, -12 20	5, LV 5, LV 5, LV 	A, C C A, C C A, A A A A A A A A A A A A	dual input †offset voltage †CE/CC Darington (npn) (pnp) Darlington (pnp) †Offset Voltage †Offset Voltage †Offset Voltage
Differential Comparator	μΑ710 μΑ710C μΑ711C ΝΜ1037 ΡΑ710	FA FA NOR PH SIG	40 ns 40 ns 40 ns 100 kHz 40 ns	†2 mV †2 mV †1 mV ±10 †2 mV	63 63 *1000 64 *1700 Open Le		-0.5 -0.5	200 200 200 3 k 200	+12,-6 +12,-6 +12,-6 30 +12-6	11111	A, C A, C A A, C A, C	† offset voltage † offset voltage dual input † offset voltage Min - Max Limit Detector † Offset
Driver Switch J	NM1038	NOR	50 kHz	±10	-	-	11 k	-	34, 6, -6	-	D	
Emitter Coupled K	MC1110	МО	DC - 300	0.114	26	10	2 k	5 k	±12	6	А	
General Purpose Amp. L	12X207 12X218 4JPA113 4JP114 MCM601 NM1032	GE GE GE KE NOR	10-100 kHz 10-100 kHz 100 kHz 1 MHz 3-100 kHz dc — 190 kHz	0.0001 - - - - -	*600 - 85 +3,000 26 45	- 50 45 0.8	10 k 50 M 20 k 1.5 4 M 34 k	1 M 250 50 10 500 2 k	30 25 15 6 +15 VDC 6, -12	10 mv rms B - - -	A E A A D	†Current gain

See pages 4-9 for manufacturer's names.
 MC= Multiple Chip; TF= Thin-film hybrid.

Linear Circuits (continued)

Function	Model	Mfr.¹	Frequency Range	In put (Volts)	Gain (db) or *(Volts)	Output (mW) or *(Volts)	Input Impedance (ohms)	Output Impedance (ohms)	Supply Voltage (Volts)	Noise Figure (db) or *(Volts)	Package Type	Remarks 2
L	NM1033 UC1501A UC1503A UC1505A UC1507A PA7602 WM108	NOR SPR SPR SPR SPR PH WH	dc - 190 kHz 3 - 250 kHz 200 Hz - 3 MHz 30 Hz - 11 MHz 10 Hz - 10 MHz 0-100 Hz 0-100 kHz	111111	66 84 60 40 34 76 †20,000	- 500 600 600 600 *6	3.4 k 2 k 20 k 47 k 47 k †>25 k 10 M	2 k 150 150 150 150 150 +<50	12, 6, -12 15 15 15 15 15 12 12		D A C	†Gain of 40dB †gm
Limiter M	UC1508A	SPR	50 Hz - 12 kHz	2	40	16	40 k	15	15	-	-	
Mixer Osc. N	WM1102	WH	30 MHz	-	.10	-	100	200	12	-	С	
Operational Amp. O	A13-251 μΑ702Α μΑ702C μΑ709C 4JPA107 4JPA135 TMC40006 MC1530 MC1531 PA702A/ 712	AL FA FA FA GE GE MEP MO MO PH	10 MHz dc-30MHz dc-30 MHz dc-500 kHz dc-500 kHz 200 kHz 100 kHz 1.2 MHz 400 kHz 0.8 MHz	- 2 mV +5 mV +1 mV +2 mV ±5 ±5 +2 mV	86 68 68 93 93 70 70 60 74 71 68	10 V *±53 *±5.3 ±14 ±10 *±4 - 10 10 *±5.3	250 k 25 k 20 k 400 k 250 k 750 k 1 M 100 k 10 k 1 M 25 k	1 k 200 200 150 150 100 100 5 k 25 25 200	±12,-6 +12,-6 ±15 ±15 ±12 ±6 ±12 ±9 ±9		A, C A, C A A A A A A, C	† offset voltage † offset voltage † offset voltage † offset voltage Darlington Input † Offset Voltage
	PA7026 Q25AH Q85AH SE506	PH PR PR SIG	0-8 MHz 0-2 kHz 0-2000 kHz 300 kHz	†7 mV ±10 ±11	68 86-116 86-116 *13,000 Open Lo	24	20 k 10 ¹² 10 ⁸ 200 k	200 100 k 100 k	12 -6 ±15 ±15 +15,-15	- 0.5 2 -	A, C G G A, C	†Offset Voltage FETs
	SN521A SN522A SN524A SN526A SN724 WS161Q PL-210 PL-212 PL-250 PL-251	TI TI TI TI WH GI GI GI	dc - 50 kHz dc - 50 kHz dc-3 MHz dc-1 MHz dc-3 MHz 500 kHz 1.5MHz 1.2MHz 30KHz 30KHz	±4 ±4 ±5 ±5 ±5 †10 ±8 ±8 ±20 ±20	62 62 60 88 54 *2000 70 64 50	70 4 70 4 - ±15 V ±10 V	12 k - 100 k 12 k - 100 k 1 M 1000 k 750 k 300 k 300 k 100k 10 M	10 k 160 75 12 k 75 40 50 150	10, 6, -9 10, 6, -9 ±12 ±12 ±12 ±12 ±18 ±12 ±12 ±12 ±12	- - - - - - 4μV 4μV	D D A, D D A, D C E E E E	Emitter follower †Offset voltage Short-circuit proof
Phase Splitter Amp.	UC1502A UC1504A UC1506A	SPR SPR SPR	3 - 250 kHz 200 Hz - 3 MHz 30 Hz - 11 MHz	-	84 58 39	160 230 230	2 k 20 k 20 k	100 100 100	15 15 15	=	=	
Power Amp. Q	MCM611 MC1524 NM1003 NM1008 WS140y WS1454	KE MO NOR NOR WH	$\begin{array}{lll} dc & - 4 \text{ kHz} \\ 300 \text{ kHz} \\ dc & - 20 \text{ kHz} \\ dc & - 20 \text{ kHz} \\ \hline \tau on < 0.45 \ \mu \text{sec} \\ \hline \text{Toff} < 1.8 \ \mu \text{sec} \\ \hline \text{Ton} < 0.45 \ \mu \text{sec} \\ \hline \text{Toff} < 1.8 \ \mu \text{sec} \\ \end{array}$	- ±5 0-60 0-60 -	- *10/20/ 54 46 hfe > 100	8000 8000 00-	8.5 k 10 k 10 k -	2 0.58 500 300 -	±15 ±12 36 36 40	-	A G G stud	Modified To-53 Modified To-53
Pulse Amp.	UC1509A UC1510A 12X264	SPR SPR GE	- - 10 MHz	5 6.7 -	22 0 25		20 k 40 k -	100, 10 100, 10 -	15 15 15	=	_ _ A	
RF/IF Amp. S	PA7602 PA713 WM1101	PH PH WH	10 - 200 MHz 0 - 200 MHz 0-3 MHz	-	18 †33 30@ 60 MHz	1 -	90 450 100	95 900 200	±6 6	7 5	A A-C	†12 MHz Video Bandwidth
Read Amp. T	WS934	WH	0-1 MHz	-	*4-32 V/	/V-	180	100	±9	4	D	
Sense Amp.	NM2012 NM2016	NOR NOR	0-1 MHz 0-1 MHz	†1 mV †4 mV	49 54	*4	Ξ	Ξ	13 30	Ξ	A, D A, D	†Offset Voltage †Offset Voltage Temp. Compensated
	SE500 SE504 SA10 SA11 SN5500 SN7500	SIG SIG SY TI TI	0-3 MHz 3000 kHz 7 MHz †125 ns †125 ns	- 17 mV 6 6	31 30 - -	11111		-	+13, +4, +1. 13 -25, 12, +5 ±6 ±6	-	A, C A, C D, G A, D D	Digital Output 0-5V † Prop. delay †Prop. delay
Summing Amp. V	4JP116	GE	100 MHz	-	1 × 10 ^s	-	1	1	±25	-	Å	
Video Amp. W	E13-511 NC/PC101 SA20 WS112y WM1106 WM1116 WM1126 WM1136 WM1146	AL GI SY WH WH WH WH	50 MHz 40 MHz up to 100 MHz 0-5 MHz 0-6 MHz 0-8 MHz 0-10 MHz 0-12 MHz 0-35 MHz	0.26 0.2 	22 20 45 25 20 20 20 20 20 20	4.5 - - - - -	520 1 k 2.6 k 1 k 100 100 100 100 100	520 500 >5 1 k 1.3 k 1.3 k 1.3 k 1.3 k	+12 6 24 12 12 12 12 12 12 12	- 3 15 6 - - - 4	A A, E A A, C, F, G C C C C	

See pages 4-9 for manufacturer's names.
 MC= Multiple Chip; TF= Thin-film hybrid.

May 17, 1966 197.

Linear Circuits (continued)

Function	Model	Mfr.1	Frequency , Range	In put (Volts)	Gain (db) or *(Volts)	Output (mW) or *(Volts)	Input Impedance (ohms)	Output Impedance (ohms)	Supply Voltage (Volts)	Noise Figure (db) or *(Volts)	Package Type	2 Remarks
Voltage Regulators	PC501	GI	100 kHz	+16to+24	-	150mA		0.2	+12	0.4 mV	E	1
X	PC502	GI	100 kHz	-16 to -24	-	150mA	_	0.2	-12	0.4 mV	E	
^	PC503	GI	100 kHz	+28 to +36	-	140mA	-	0.4	+24	1 mV	E	
	PC504	GI	100 kHz	-28 to -36	_	140 mA	4 A A	0.4	-24	1 mV	E	
	NC/PC51	1 GI	100 kHz	+15 to +24	-	150mA	-	0.1	+12	0.4 mV	A or E	
	PC512	GI	100 kHz	+27 to +36	-	140mA		0.2	+24	1 mV	E	
	NC/PC51	3 GI	100 kHz	-15 to -24	-	150mA		0.1	-12	0.4 mV	AorE	
	PC514	GI	100 kHz	-27 to -36	-	140mA	-	0.2	-24	1 mV	E	
	PL-521	GI	100KHz	+28	-	+6V	-	0.05	-	-	E	Imax=200 mA
	PL-523	GI	_	-28	-	-6 V	200-200	0.05	-	-	E	Imax=200 mA
	NCS-675A		-	+28	/-	+5V		0.1	-	-	A	Imax=200mA
	NM1004	NOR	-	>20, >30		†1.25mA	-	-	715	1 mV		†Drive Current

- 1) See pages 4-9 for manufacturer's names.
- 2) MC= Multiple Chip; TF= Thin-film hybrid.





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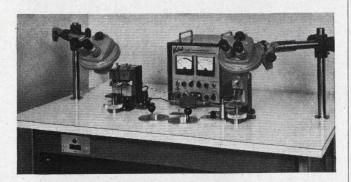
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NUMERICAL 4JP 8E	A50 A51	1E4 1A	—Е—	0.5	MC207 MC208	1E4 1E4
4JP114 8L 4JP116 8V 4JP380 8F 4JP912 8B	A52 A53 A54 A55	1E4 1E4 1E4 1E4	E11001 E11004 E13-511 E16-501	2F 2F 8W 8B	MC209 MC212 MC213 MC215	1B 1E4 1E4 1E1
4JP913 8B 4JPA107 80	A60 AMC101	1D 8C	—F—		MC217 MC251	7B 1E4
4JPA113 8L 4JPA135 80 12X207 8L	—В—		FF1514B FF7317E	2B 5A	MC252 MC253 MC254	1E4 1E1 1E4
12X218 8L 12X264 8S	B01 B02	3D3 3D3	FF8317E FμL90029 FμL90329	5A 2C 2E1	MC255 MC256	1D 1E4
203 8200 8BH 1B	B11004 BC11001	2C 2C	F _μ L90529 F _μ L91029	2I 2E1	MC257 MC258 MC259	1E4 1E4 1B
8201 1H 8202 1H 8203 1I	—C—	O.D.	FμL91129 FμL91429 FμL91529	2E1 2E1 2E1	MC260 MC262	1B 1E4
8204 1E5 8207 1E1	C11001 C11004 CS700	2D 2D 1E4	F _μ L92129 F _μ L92329	2F 2B	MC263 MC265 MC267	1E4 1E1 7B
8208 1E1 8209 1E1 8210 1E1	CS701 CS704	1E4 1B 1E1	—G—		MC281G MC282G	1E4 1B
8213 1D 8214 1E3	CS705 CS709 CS715	1F 1D	G11001 G11004	2E1 2E1	MC284G MC301 MC302	1E4 4D3 4B
8502 8C	CS716 CS720 CS721	1E4 1E4 1E4	GG1514B GG3317	2E1 5C	MC303 MC304	4A 4C
A01 1E4 A02 1E4	CS727 CS729	1E4 1B	— H —	2A	MC305 MC306 MC307	4E 4D3 4D3
A03 1B 1F	CS730 CS731 CS732	1E4 1F 1F	H11004	2A	MC308 MC309	4B 4D1
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A08 A09 1B	CT _μ L954 CT _μ L955 CT _μ L956	6C1 6C1 6B	J11004 — K —	2E1	MC315 MC351	4C 4D3
A10 1E4, 2E2 A11 2A, 2E2 A12 1E4	CTμL957	6A	K11001	2E1	MC352 MC353 MC354	4B 4A 4C
A13 1E4, 2B A13-251 80	— D —	8H	K11004 —L—	2E1	MC355 MC356	4E 4D3
A14 1E4, 2E2 A15 1E4, 2H A16 2B	D13-001 D13-002 DM3510B	8H 8H 5D	L11001 L11004	2E1 2E1	MC357 MC358 MC359	4D3 4B 4D1
A17 2B A20 1D	DT _μ L930 DT _μ L931	1E4 1B	—M—		MC360 MC361	4D1 4D1
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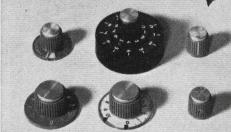


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NC/PC101	W8
NC/PC511	8X
NC/PC513	8X
ND1002	1D
ND1003	1B
ND1006	1E6
NM1003 NM1004	8Q 8X
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NM1008	8H 8Q
NM1021	8H
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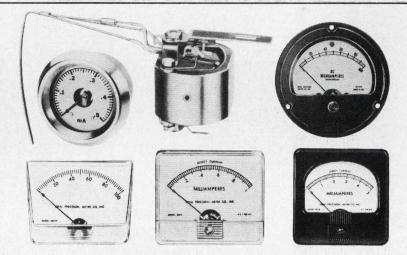


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	SN1731	2E1	SN15846	1E3
SN5112 5A SN15932 1D SN5113 5A SN15933 1F SN5161B 5C SN15944 1E3 SN5162B 5C SN15945 1B SN5191 5C SN15946 1E3 SN5301 1B SN15948 1B SN5302 1B SN15950 1B SN5304 1B SN15951 1I SN5304 1B SN15962 1E3 SN5311 1E4 SN54930 3D2 SN5331 1E4 SN54932 3C SN5360 1E4 SN54932 3C SN5370 1E6 SN54948 3B SN5380 1I SN54962 3D2 SN5400 3D2 SN54965 3D2 SN5410 3D2 SN54966 3D4 SN5420 3D2 SN74930 3D2 SN5430 3D2 SN74930 3D2 SN5430 3D2 SN74930	SN1733 SN1734 SN1735 SN5101B	2E1 2A 21	SN15850 SN15851 SN15862 SN15930	1B 1I 1E3 1E3
SN5191 5C SN15946 1E3 SN5301 1B SN15948 1B SN5302 1B SN15950 1B SN5304 1B SN15951 1I SN5311 1E4 SN54932 3D2 SN5331 1E4 SN54932 3C SN5360 1E4 SN54946 3D2 SN5370 1E6 SN54948 3B SN5380 1I SN54962 3D2 SN5400 3D2 SN54965 3D2 SN5410 3D2 SN54966 3D4 SN5420 3D2 SN74930 3D2 SN5430 3D2 SN74930 3D2 SN5430 3D2 SN74932 3C	SN5112	5A	SN15932	1D
	SN5113	5A	SN15933	1F
	SN5161B	5C	SN15944	1E3
SN5311 1E4 SN54930 3D2 SN5331 1E4 SN54932 3C SN5360 1E4 SN54946 3D2 SN5370 1E6 SN54948 3B SN5380 1I SN54962 3D2 SN5400 3D2 SN54965 3D2 SN5410 3D2 SN54966 3D4 SN5420 3D2 SN74930 3D2 SN5430 3D2 SN74932 3C	SN5191	5C	SN15948	1B
	SN5301	1B	SN15950	1B
	SN5302	1B	SN15951	11
SN5400 3D2 SN54965 3D2 SN5410 3D2 SN54966 3D4 SN5420 3D2 SN74930 3D2 SN5430 3D2 SN74932 3C	SN5331 SN5360 SN5370	1E4 1E4 1E6	SN54930 SN54932 SN54946 SN54948	3D2 3C 3D2 3B
011212	SN5400	3D2	SN54965	3D2
	SN5410	3D2	SN54966	3D4
	SN5420	3D2	SN74930	3D2
SN5450 3D4 SN74948 3B SN5451 3D4 SN74962 3D2 SN5453 3F SN74965 3D2 SN5460 3E SN74966 3D4	SN5450 SN5451 SN5453	3D2 3D4 3D4 3F	SN74946 SN74948 SN74962 SN74965	3D2 3B 3D2 3D2

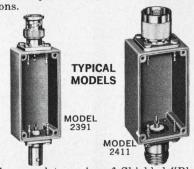
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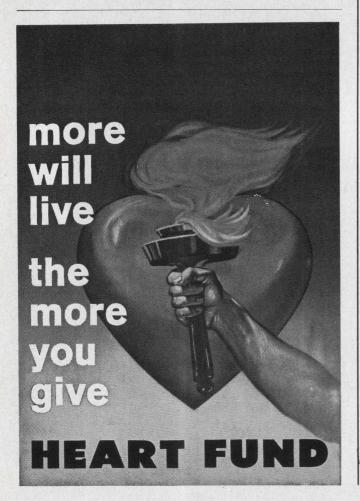


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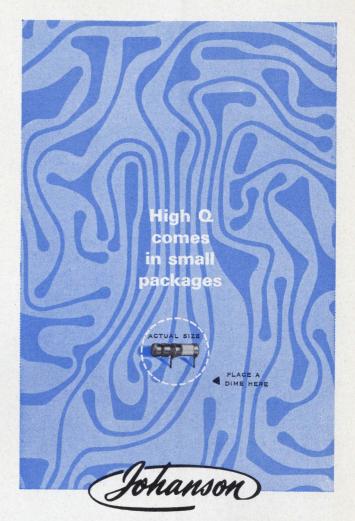
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SU305 SU306 SU314 SU315 SU316 SU320 SU331 SU332 SW101 SW102 SW103 SW104 SW115 SW201 SW204 SW211 SW212 SW221 SW221 SW221 SW221 SW305 SW306 SW307 SW308 SW309 SW310 SW309 SW310 SW311 SW402 SW708 SW930 SW931 SW932 SW933 SW944 SW945 SW946 SW948 SW946 SW948 SW962 SW5400 SW5410 SW5420 SW5440 SW5440 SW5440 SW5440 SW5440 SW5450 SW5440 SW5440 SW7400 SW7410 SW7400 SW7410 SW7400 SW7410 SW7400 SW7410 SW7420 SW7450 SW7460 SW7470 SW7400 SW7410 SW7450 SW7460 SW7470 SW7400 SW7410 SW7450 SW750 SW750 SW750 SW750 SW750 SW750 SW750 SW750	7K 7K K 1E3 3D2 31E3 1E3 1E3 4 4D2 4B 11 1D 1 1D B 3D2 2D2 2D2 2D2 2D2 3D3 3D3 3D3 3D3 3D3	SWF263 SWG4A SWG4A SWG4B SWG5A SWG5B SWG14 SWG16 SWG21 SWG40 SWG41 SWG42 SWG43 SWG50 SWG51 SWG52 SWG53 SWG60 SWG51 SWG62 SWG63 SWG90 SWG91 SWG92 SWG93 SWG100 SWG101 SWG102 SWG103 SWG100 SWG111 SWG112 SWG122 SWG133 SWG120 SWG121 SWG122 SWG133 SWG140 SWG131 SWG122 SWG133 SWG140 SWG131 SWG132 SWG133 SWG140 SWG131 SWG132 SWG133 SWG140 SWG151 SWG153 SWG177 SWG153 SWG177 SWG173 SWG180 SWG151 SWG172 SWG153 SWG170 SWG171 SWG172 SWG183 SWG170 SWG171 SWG172 SWG183 SWG170 SWG171 SWG172 SWG183 SWG210 SWG211 SWG212 SWG222 SWG223 SWG223 SWG223 SWG223 SWG223 SWG224 SWG242	3B 3D2 3D1 3D2 3D1 3D2 3D1 3D2 3D2 3D1 3D1 3D1 3D1 3D1 3D1 3D1 3D1 3D1 3D1
SWF251	3B	SWG242	3D2
SWF252	3B	SWG243	3D2

SWG250	3D1	USO101A	5A
SWG251	3D1	USO102A	5C
SWG252	3D1	USO103A	5C
SWG253 SWG260 SWG261 SWG262	3D1 3D2 3D2 3D2	—W— WC183G WM108	8C 8L
SWG263	3D2	WM201	1E3
SWG270	3E	WM202	1B
SWG271	3E	WM203	1B
SWG272	3E	WM204	1E3
SWG273 —T—	3E	WM205 WM206 WM208T WM210	1J 1E3 7C 1D
T35-002	2H	WM211	1E3
TFF3011	3B	WM212	1B
TFF3013	3B	WM213	1B
TFF3015	3B	WM214	1E3
TFF3017	3B	WM215	1B
TMC40001	5C	WM216	1E3
TMC40002	5D	WM217	1F
TMC40003	5A	WM221	1E3
TMC40004	5C	WM224	1E3
TMC40005	8H	WM225G	1B
TMC40006	80	WM226G	1E3
TNG3011	3D3	WM227	1F
TNG3013	3D3	WM231	1E3
TNG3015	3D3	WM234G	1D
TNG3017	3D3	WM236G	1E3
TNG3031	3D3	WM241G	1E3
TNG3041	3D3	WM246	1E3
TNG3043	3D3	WM246G	1E3
TNG3045	3D3	WM261G	1E3
TNG3047	3D3	WM286G	1E3
TNG3051 TNG3111 TNG3113 TNG3115 TNG3117	3E 3D3 3D3 3D3 3D3	WM296G WM503 WM506 WM510	1E3 1B 1E3 1D
TNG3117 TNG3131 TNG3141 TNG3143 TNG3145	3D3 3D3 3D3 3D3	WM556 WM701 WM704 WM1101	1E3 3D3 3D3 8S
TNG3147 TNG3211 TNG3213 TNG3215	3D3 3D3 3D3 3D3 3D3	WM1102 WM1106 WM1116 WM1126	8N 8W 8W 8W
TNG3217 TNG3231 TNG3241 TNG3243	3D3 3D3 3D3 3D3 3D3	WM1136 WM1146 WM1146Q WS112y	8W 8W 8E 8W
TNG3245	3D3	WS115	8H
TNG3247	3D3	WS123	8H
TNG3251	3E	WS140y	8Q
TT _µ L103	3D3	WS141G	8H
TT _{\(\mu\)} L104 —U—	3D3	WS142 WS143G WS144 WS150	8H 8H 8H 1C
UC1001B	1E3	WS150Q	7D
UC1002B	1B	WS151	8D
UC1003B	1D	WS153	8H
UC1004B	1A	WS161Q	80
UC1005B	1F	WS277	2E2
UC1006B	1F	WS371	4D1
UC1501A	8L	WS810Q	1E2
UC1502A	8P	WS811Q	1E3
UC1503A	8L	WS812Q	1E2
UC1504A	8P	WS813Q	1E1
UC1505A	8L	WS814Q	1E2
UC1506A	8P	WS815	1C
UC1507A	8L	WS816	1D
UC1508A	8M	WS817	1D
UC1509A	8R	WS817Q	1D
UC1510A	8R	WS934	8T
USO100A	5A	WS1454	8Q



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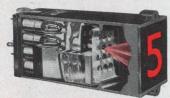


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ON READER-SERVICE CARD CIRCLE 26

Why IEE rear-projection readouts make good reading

Not the kind of good reading you'd curl up with on a rainy night. But a more important kind if you're designing equipment that requires message display. Reason is that IEE readouts are the most readable readouts around. If you've seen them, you know this to be fact. If you haven't as yet, here is why our readouts make such good reading:



SINGLE-PLANE PRESENTATION

No visual hash of tandem-stacked filaments. IEE readouts are miniature rear-projectors that display the required messages, one at a time, on a non-glare viewing screen. Only the message that's "on" is visible.



EASY-TO-READ CHARACTERS

Since IEE readouts can display anything that can be put on film, you're not limited to thin wire filament, dotted, or segmented digits. Order your IEE readouts with familiar, highly legible characters that meet human factors and Mil Spec requirements. This section from our sample type sheet gives you an idea of the styles available that offer optimal stroke/width/height ratio for good legibility.

BALANCED BRIGHTNESS/CONTRAST RATIO

The chart below is a reasonable facsimile of character brightness and how



it affects readability. The background is constant, but the brightness increases from left to right. You can draw your own conclusions, armed with the fact that IEE readouts give you up to 90 foot lamberts of brightness. Brightness, however, isn't the sole factor in judging readability. Background contrast is equally important—a fact we've simulated below, reading from left to right.



Obviously, brightness without contrast or vice versa, doesn't do much for readability. A balanced ratio of both gives you the crisp legibility of IEE readouts.



IEE's unique combination of singleplane projection, flat viewing screen, balanced ratio of brightness/contrast, and big, bold characters makes for wide-angle clarity and long viewing distances.

OTHER WAYS IEE READOUTS MAKE GOOD SENSE

As if the superior readability of our readouts weren't enough, here are a few reasons why IEE readouts make good sense in other areas:









INFINITE DISPLAY VERSATILITY

Because our readouts use lamps, lenses, film, and a screen, they can display literally anything that can be put on film. That means you have up to 12 message positions with each readout to display any combination of letters, words, numbers, symbols, and even colors!



FIVE SIZES TO PICK FROM

IEE readouts now come in five sizes providing maximum character heights of %", %", 1", 2", and 3%". The smallest is the new Series 340 readout that's only ¾" H x ½" W, yet can be read from 30 feet away. The largest, the Series 80, is clearly legible from 100 feet away.

EASY TO QPERATE

IEE readouts are available with voltage requirements from 6 to 28 volts, depending on lamps specified. Commercial or MS lamps may be used, with up to 30,000 hours of operation per lamp. Lamps may be rapidly replaced without tools of any kind.

Our readouts operate from straight decimal input or will accept conventional binary codes when used with IEE low-current driver/decoders.

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MODEL 665 TRANSISTOR TEST SYSTEM (upper left)

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A portable a-c test instrument for measuring bulk, slice and sheet resistivity of semiconductor material. A 5-point probe gives high accuracy. Range is from .001 to 300 ohm-cm fs; 0.1 to 3000 ohms/sq.



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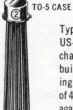
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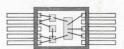
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2 PNP	4 PNP
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